ANNUAL REPORT

OF

THE BOARD OF REGENTS

OF THE

University of Minnesota

TO THE GOVERNOR,

FOR THE

FISCAL YEAR ENDING DECEMBER 29th, 1877.

SUBMITTED TO THE LEGISLATURE OF THE TWENTIETH ANNUAL SESSION, 1878.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON
1878.

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UNIVERSITY OF MINNESOTA.
OFFICE OF THE BOARD OF REGENTS,
December 29, 1877.

To His Excellency, J. S. Pillsbury,

Governor of Minnesota:

SIR.—In compliance with the law I have the honor to forward herewith the annual report of the Board of Regents of the University of Minnesota, for the fiscal year ending this day.

Very respectfully,

Your obedient servant,

HENRY H. SIBLEY,

President.

	Term Expires.
The Hon. WILLIAM R. MARSHALL, St. Paul	1878.
The Hon. A. A. HARWOOD, Austin	1878.
The Hon. HENRY H. SIBLEY, St. Paul	1879.
The Hon. THOS. S. BUCKHAM, M. A., Faribault	1879.
The Hon. PARIS GIBSON, M. A., Minneapolis	1880.
The Hon. MORRIS LAMPREY, M. A., St. Paul	1880.
The Hon. RICHARD CHUTE, Minneapolis	1880.

and ex officiis,

The Governor of the State,

The Hon. JOHN S. PILLSBURY, Minneapolis.

The State Superintendent of Public Instruction,

The Hon. D. BURT, M. A., St. Paul.

The President of the University,

WILLIAM W. FOLWELL, Minneapolis.

OFFICERS OF THE BOARD.

Hon. HENRY H. SIBLEY, President.
Hon. PARIS GIBSON, Recording Secretary and Treasurer.
WILLIAM W. FOLWELL, Corresponding Secretary.

OFFICERS AND EMPLOYES

FOR THE UNIVERSITY YEAR. 1876–77.

WILLIAM W. FOLWELL, PRESIDENT,
Instructor in Political Economy and Librarian.

G. CAMPBELL, M. A., B. D., VICE PRESIDENT,
Professor of Mental and Moral Philosophy.

Professor of the Latin Language and Literature.

JABEZ BROOKS, M. A., D. D.,
Professor of the Greek Language and Literature,
and in charge of the Dept. of Latin.

EDWIN J. THOMPSON, M. A.,
Professor of Mathematics and Astronomy.

NEWTON H. WINCHELL, M. A., STATE GEOLOGIST,
Professor of Geology and Mineralogy.

CHARLES N. HEWITT, M. D.,
Non-Resident Professor of Public Health.

MITCHELL D. RHAME, M. A.,
Professor of Civil and Mechanical Engineering

STEPHEN F. PECKHAM, M. A.,
Professor of Chemistry and Physics.

JOHN G. MOORE, B. A.,
Professor of North European Languages.

MOSES MARSTON, M. A.,
Professor of the English Language and Literature.

RICHARD W. LAING, LL. D.,
Professor of History, and in charge of French.

JOHN A. LUNDEEN, U. S. A.,
Professor of Military Science.

CHARLES Y. LACY, B. Agr.,
Assistant Professor in charge of Theory and Practice of Agriculture.

LOUIS W. PECK,
Instructor in Physics and Drawing.

MRS. AUGUSTA NORWOOD SMITH, PRECEPTRESS,
Instructor in English and History.

JOHN C. HUTCHINSON, B. A.,
Instructor in Latin and Greek.

JOHN S. CLARKE, B. A.,
Assistant Librarian and Instructor in Mathematics.

During the first two terms Professor JOHN B. CLARK, now of Carleton College, gave instruction in Latin, under a temporary engagement, to the entire satisfaction of the professor in charge.

In the spring term Mr. HENRY C. LEONARD taught Botany acceptably under the direction of Professor WINCHELL.

EMPLOYES. 1876–77.

W. T. SCOTT, *until April 1st*, Farmer.
JOHN BRADLEY EUSTIS, *after April 1st*, Farmer.
G. C. CAMPBELL, Assistant in Library.
CLARENCE C. HERRICK, Assistant in Museum.
CHAS. W. SAVIDGE, Assistant in Chemical Laboratory.
J. CLARENCE BRYANT, Janitor of Main Building.
GEO. A. WOOD, Janitor of Agricultural Building, and Assistant in Plant House.

STEPHEN MAHONEY, Fireman.
FRED. C. BOWMAN, Carpenter.
EVAN R. PRITCHARD, Leader of Choir.

All of these employes except the first two named were students, who depended upon the compensation received for these and other labors for their support.

OFFICIAL CHANGES.

During the session of the Legislature, Regents Gibson, Lamprey, and Chute were reappointed by the Governor, with the consent of the Senate, for the term of three years, and Hon. D. Burt having been reappointed to the office of Superintendent of Public Instruction, continued to be regent *ex officio*.

First Lieutenant John A. Lundeen, of the Fourth U. S. Artillery, whose appointment to the position of professor of Military Science and Tactics was referred to in the last report, entered upon the duties soon after the beginning of the year. Professor Lundeen has given valuable assistance in the departments of mathematics and astronomy.

The Board are gratified to state that at the date of filing this report the total enrollment of students for the new college year has risen to above three hundred and sixty. The Board attribute this increase to the improved financial condition of the State, the result of the late bounteous harvest, and to the system of examinations for admission held under authority of the Board during the past summer in several of the cities and larger villages of the state.

COURSES OF STUDY.

At the spring meeting of the Board, revised courses of study in the several departments of the University carefully prepared by the General Faculty, were, after suitable deliberation and scrutiny, adopted. The greater number of changes from the previous schedules were merely transpositions of subjects from term to term in order to distribute the work of the several professors and instructors more equally.

The Board are of the opinion that under the new arrangement a large increase of students can be instructed without materal increase of the teaching force.

GRADUATES.

At the Fifth Annual Commencement, held in June last, sixteen degrees were, upon recommendation of the Faculties, conferred upon the same number of persons; thirteen gentlemen and three ladies. This is the largest class that has yet been graduated. There is every reason to believe that this number will be equalled if not exceeded by succeeding classes. The whole number of graduates up to date is thirty seven; thirty-two gentlemen and five ladies.

Upon the occasion referred to the Board were again placed under obligations to Major Gen. Sykes, U. S. A., for the use of his head-quarters band, that of the 20th U. S. Infantry. The attendance upon the occasion was very large and the performances of the candidates were highly creditable to themselves and gratifying to the Board.

ATTENDANCE.

The attendance of students for the year (1876–7) ending in June last, is shown in the following tables:

SUMMARY—1876-7.

COLLEGE OR DEPARTMENT.	CLASS.	Gentlemen.	Ladies.	Totals.
Science, Literature and the Arts	Graduates	1	1	2
	Senior	14	4	18
	Junior	11	3	14— 34
Mechanic Arts	Senior	1	....	1
	Junior	2	....	2—3
Agriculture, Advanced Course	Junior	1	....	1
Agriculture, Elementary Course	III and IV	1	....	1— 2
Collegiate Department	First	23	14	37
	Second	18	12	30—106
	Third	47	18	65
	Fourth	51	22	73—138
	Special	40	19	59— 59
Totals		210	93	*303

* In the calendar for 1876-7, one name was counted twice by mistake, making this total 304.

OR BY CLASSES ONLY,

Graduates	2	
Seniors—of all Departments	19	
Juniors—of all Departments	17	
Sophomores—First Class, Collegiate Department	37	
Freshmen—Second Class, Collegiate Department	31	—106
Preparatory, Third Class, Collegiate Department	65	
Preparatory, Fourth Class, Collegiate Department	73	—138
Special	59	— 59
Total		303

BUILDINGS.

The buildings of the University, although seemingly spacious, are at the present time completely occupied, and in several instances the class rooms are inadequate to the suitable accommodation of the classes. It can not be long before the space now occupied by the Assembly Hall, the Library and the Museum in the main building, must be given over to instruction, and those establishments transferred to other quarters.

We respectfully and earnestly renew the recommendation of last year in regard to a drill hall and gymnasium, the need of which is more and more apparent and pressing.

In the Agricultural College building a new class room has been fitted up for the departments of Physics, Chemistry, etc., the room formerly in use being too small to admit the classes. A small room for the storage of apparatus has also been partitioned off in the corridor of the upper story.

The two buildings have been connected by a line of telegraph, and the Instructor in Physics, Mr. L. W. Peck, has lately constructed an experimental telephone.

The plant house, first opened late last season, has been successfully managed, at a moderate expense, and has proved valuable as an aid to scientific instruction.

LIBRARY.

Including the books and pamphlets turned over by legislative authority from the State Library, the accessions of the year have been considerable. Unfortunately so many of the works of the lot referred to were damaged by loss of volumes belonging to sets, that its value was greatly diminished.

Upon the urgent recommendation of the General Faculty, the Board ventured last year to raise the appropriation for the increase of the library to one thousand ($1,000) dollars, which sum has been judiciously expended. There is still a great need of books for some departments, especially the scientific and mechanical, and the Board sincerely regret that they have no present means for supplying this need. The report of the Librarian is referred to for details.

GENEAL MUSEUM.

In order to display the collections of the Geological Survey, and render them available for purposes of instruction and investigation, the sum of one thousand ($1,000) dollars was set apart some months

ago to construct cases and fit up an additional room to contain them. This work will soon be completed and the specimens properly classified and displayed.

The Board regret that, owing to delays incident to the mounting of the large Megatherium, it has been thought necessary to keep the present room closed for some months past.

For a detailed statement of accessions in amount and value, reference is made to the report of the Curator, Prof. Winchell.

UNIVERSITY CAMPUS.

The liberality of the last Legislature in appropriating the sum of eighteen thousand ($18,000) dollars for the enlargement of these grounds, has enabled the Board to purchase upon equitable terms the following property:

1. The land of Mr. G. D. Perkins, lying south of University avenue and Twelfth avenue southeast, for the sum of nine thousand ($9,000) dollars.

2. The equivalent of six lots in Thatcher's Addition of Mr. A. R. Camp, for the sum of two thousand ($2,000) dollars.

3. Sixteen lots in Thatcher's Addition, of various parties, for the sum of $———

Proceedings for the condemnation of the remainder of the property necessary to complete the proposed enlargement, as shown on map in last report, page eleven (11,) are still pending but are held in abeyance for lack of ready funds to deposit in court, and thus to obtain indisputable title. It would be manifestly unfair to the owners of this property to exclude it from market in this manner indefinitely, and the Board sincerely trust that means will soon be afforded them of carrying out the policy fixed and inaugurated by the State of securing for this institution a campus commensurate with its needs, and isolated from unsuitable surroundings. It is highly important that this indispensable enlargement be consummated before the adjacent property shall have risen in value, and while the owners are willing to dispose of it upon reasonable terms. For the Campus, Drill Hall and Gymnasium and other objects hereafter mentioned, we would respectfully ask for an appropriation of twenty-five thousand dollars.

GEOLOGICAL SURVEY.

The operations of the survey have been confined in the main to the counties of Ramsey, Rice, Rock, and Pipestone. For detailed accounts of this work reference is made to the report of Professor Winchell.

Upon invitation of the State Board of Health, Professors Winchell and Peckham were authorized, in June last, to accompany Dr. C. N. Hewitt, representing the Board of Health, to investigate the water supply of the Red River Valley. The views and conclusions of these officers upon this subject will be found in their respective reports.

A number of minor investigations and reconnoissances conducted by Professor Winchell and his assistants, will be found in their proper connection.

AGRICULTURAL COLLEGE AND FARM.

The detailed report of Professor Lacy herewith transmitted, shows the nature and extent of the various changes and improvements as well as the experiments which have been prosecuted. The number of farmers sons in attendance seeking instruction in general science and letters, is as heretofore very large, while the number of students of scientific agriculture does not increase, and probably cannot materially be augmented until our agriculturists learn to diversify their products and cease to raise for market a single staple.

The Board feel themselves indebted to Mr. Lacy for his energy and intelligence in exhibiting the productions of the experimental farm and the plant house, at the late State Fair. The exhibition appears to have been very generally appreciated by the public as in a high degree interesting and instructive.

FINANCES.

The resources of the University consist of lands granted by Congress for the endowment of the University and of those granted to the state under the law of July 2, 1862, donating lands for the benefit of agriculture and the mechanic arts.

The State Auditor reports the following sales of land during the fiscal year, with other statistics, as follows:

Balance in State Treasury Dec. 1, 1876	$ 1,182 34

Received during the year on account of—

Appropriation from State Institutions Fund		$12,000 00	
Sales of Agricultural College Lands for former years		1,275 08	
Sales of Agricultural College Lands, 1877	$8,154 03		
Less Unpaid Draft Faribault Co	978 00		
		7,176 03	
Sales of Pine Timber on University Lands		2,139 96	
			$22,591 07
			$23,773 41

The total amount of accumulations of permanent University fund at the close of the fiscal year appears from the auditors report to be $353,989.81.

As the Board have no immediate control over this fund, but merely draw and expend the income according to law, reference is made to the Auditor's annual report for full information in regard to it.

Herewith I have the honor to transmit the financial statement to the Treasurer for the fiscal year, showing in detail all the receipts and expenditures, accompanied with proper vouchers.

All the items and footings have been fully inspected and verified by the auditing committee of the Board, and the report has thereupon been approved and accepted by the Board.

GENERAL OUTLOOK.

On the seventh of October last, the University of Minnesota completed its tenth birthday. The Board feel that they have reason, with the people of the state, to take pride in the growth and progress of the institution. Beginning ten years ago with 40 young preparatory students, the attendance in the last college year rose to (303) three hundred and three. There is at the present time a larger number of students in actual attendance than was ever before enrolled in the whole course of any academic year.

Notwithstanding this large increase the Board have not felt able or authorized to increase the teaching force which remains as to numbers the same as during the previous year. Miss M. J. Campbell, a graduate of the University, and an experienced teacher, has performed the duty previously devolved upon Mr. J. B. Clark. The professorship of Latin vacated by the lamented death of Professor V. J. Walker, still remains unfilled, the chair having been placed in charge of Professor Brooks, and the duties performed by him together with that of the department of Greek, with the assistance of instructors, Hutchinson and J. S. Clark. The year has been one of peaceful and decided progress. The faculty, composed of capable and earnest men, having at heart the highest interests of the institution and of their pupils, have labored with great diligence and in entire harmony. The conduct and deportment of the young people committed to their care cannot, we believe, be surpassed in good order and diligent application by any similar body in our country. And this, we are of opinion, is in a great measure due to the salutary influence of the joint attendance and instruction of the young men and young women, as well as to the judicious policy

of the faculty in avoiding the use of unnecessarily strict and arbitrary rules and regulations.

The report of the President of the University is referred to for numerous details, recommendations and professional suggestions, and which are generally accepted by the Board as judicious and wise.

All of which is respectfully submitted,

TREASURER'S REPORT.

PARIS GIBSON, *Treasurer, in Account with the Board of Regents.*

CURRENT EXPENSE.

DR.

1877.				
Jan.	19,	To Cash drawn from State Treasurer..................	$3,000 00	
Feb.	5,	To Cash drawn from State Treasurer..................	2,000 00	
"	19,	To Cash drawn from State Treasurer..................	2,000 00	
"	27,	To Cash drawn from State Treasurer..................	2,500 00	
April	7.	To Cash drawn from State Treasurer..................	3,000 00	
"	25,	To Cash drawn from State Treasurer..................	3,000 00	
May	2,	To Cash drawn from State Treasurer..................	1,500 00	
"	26,	To Cash drawn from State Treasurer..................	3,500 00	
June	6,	To Cash drawn from State Treasurer..................	3,500 00	
July		To Cash drawn from State Treasurer..................	1,000 00	
"		To Cash drawn from State Treasurer..................	1,000 00	
Aug.	28,	To Cash drawn from State Treasurer..................	2,000 00	
Sept.	27.	To Cash drawn from State Treasurer..................	3,500 00	
Oct.	26,	To Cash drawn from State Treasurer..................	3,000 00	
Nov.	6,	To Cash drawn from State Treasurer..................	500 00	
"	16,	To Cash drawn from State Treasurer..................	1,000 00	

CR.

By Balance at last Statement..........................		$5,638 84
By Balance Incidentals..................................		2,358 17
By Balance Salaries.....................................		23,443 33
By Balance Employes and Workmen.................		1,279 44
By Balance Advertising................................		645 03
By Balance Plant House...............................		270 14
By Balance Fuel...		1,859 27
By Balance Chemical Laboratory.....................		38 03
By Balance Repairs.....................................		953 13
By Balance Experimental Farm........................		1,430 17
By Balance Library and Reading Room		3,708 50
By Balance Museum....................................		603 03
To Balance...	6,227 08	
	$42,227 08	$42,227 08

INCIDENTALS.

DR.

Feb.	28,	To Cash, Students' Fees	$45 00
"		To Cash, Students' Fees	90 00
"		To Cash, Stamped Envelopes	3 30
"		To Cash	3 00
"		To Cash, 2 Lights of Glass	35
"		To Cash, Stamps	2 00
"		To Cash, Postal Order	3 00
"		To Cash, Students' Fees	15 00
Sept.	27,	To Cash, Students' Fees	1,550 00
"		To Cash	6 32

CR.

1876.					
Dec.	20,	By Cash, Organ Rent	Voucher No.	1.	$12 00
"	20,	By Cash, Freight	"	2.	6 30
"	22.	By Cash, Welles	"	3.	10 10
"	22.	By Cash, Express	"	5.	12 75
"	23,	By Cash, Grate bars	"	6.	10 00
"	27,	By Cash, Freight	"	4.	2 45
"	23,	By Cash, Sundries	"	7.	3 80
"	30,	By Cash, Regent Harwood's Ex	"	10.	14 25
1877.					
Jan,	6,	By Cash, Printing	"	12.	37 50
"	6,	By Cash, Printing	"	13.	1 75
1876.					
Dec.	20,	By Cash, Herrick	"	18.	20 75
1877.					
Jan.	15.	By Cash, Dr. Hewitt	"	26.	25 00
"	26.	By Cash, Stetson & Nelson	"	33.	17 00
"	31,	By Cash, Bryant	"	48.	7 80
Feb.	10,	By Cash, Stationery	"	53.	19 78
"	10,	By Cash, Printing	"	54.	40 75
"	13.	By Cash, Hawes & Smith	"	55.	8 20
"	13,	By Cash, Printing	"	56.	18 50
"	14,	By Cash, Williams	"	57.	8 19
"	16,	By Cash, Stationery	"	58.	11 00
1876.					
Dec.	9,	By Cash, Mrs. Bayliss	"	63.	5 00
1877.					
Jan,	3,	By Cash, Freight	"	64.	2 70
"	4,	By Cash, Express	"	65.	90
"	4,	By Cash, Hawes & Smith	"	66.	6 60
Feb.	6,	By Cash, Freight	"	67.	4 80
"	15,	By Cash, Savidge	"	68.	3 00
"	16,	By Cash, Band	"	69.	6 00
"	23,	By Cash, Sanford & Washburn	"	70.	3 34
"	26,	By Cash, Davidson & Co	"	71.	2 50
"	26,	By Cash, Repairs	"	74.	3 21
Mar.	1,	By Cash, Stationery	"	86.	10 52
"	6,	By Cash, Cauvet	"	87.	4 01
"	7,	By Cash, Tribune Co	"	89.	14 90
"	10,	By Cash, Organ Rent	"	92.	27 40
"	20,	By Cash, Herrick	"	96.	20 50
"	26,	By Cash, Alcohol	"	100.	3 00
April	14,	By Cash, Hildreth	"	109.	8 85
"	25,	By Cash, Swett	"	112.	14 12
"	27,	By Cash, Engraving Seal	"	118.	12 00
May	1,	By Cash, Clarke	"	127.	25 00

May	2,	By Cash, Currie	Voucher No.	129.	7 90
"	5,	By Cash, Oil	"	133.	4 75
"	5,	By Cash, Brooms	"	135.	4 95
"	7,	By Cash, Fire Extinguishers	"	136.	175 00
"	12,	By Cash, Harmon	"	139.	15 95
"	12,	By Cash, Printing	"	140.	14 50
Mar.	22,	By Cash	"	98.	15 69
"	1,	By Cash, Express	"	154.	75
"	5,	By Cash, Perkins	"	155.	3 00
April	9,	By Cash, Express	"	156.	2 95
"	10,	By Cash, Bryant	"	157.	1 80
"	12,	By Cash, Mahoney	"	158.	75
"	30,	By Cash, Stationery	"	163.	20 50
May	3,	By Cash, Express	"	166.	1 90
"	19,	By Cash, Telegrams	"	168.	1 00
"	22,	By Cash, Freight	"	169.	5 25
"	28,	By Cash, Telegrams	"	172.	2 00
"	28,	By Cash, Diploma and Plate	"	173.	149 50
"	31,	By Cash, Department of Chemistry	"	183.	1 25
"	31,	By Cash, Department of Physics	"	184.	4 90
June	2,	By Cash, Telegram	"	186.	25
"	4,	By Cash, Gas Lights	"	189.	2 00
"	4,	By Cash, Dr. Brooks's Room	"	190.	37 92
"	4,	By Cash, Stationery	"	192.	16 31
"	6,	By Cash, Organ Rent	"	195.	5 00
"	6,	By Cash, Printing	"	196.	12 00
"	7,	By Cash, Livery	"	197.	5 00
"	7,	By Cash, Dinner for Band	"	198.	13 50
"	11,	By Cash, Express	"	208.	25
"	12,	By Cash, Express	"	209.	25
"	15,	By Cash, Stationery	"	212.	7 50
"	18,	By Cash, Stationery	"	213.	16 61
"	16,	By Cash, Prescott	"	215.	2 00
"	22,	By Cash	"	220.	12 23
"	22,	By Cash, Express	"	221.	1 00
"	15,	By Cash, Astronomical Slides	"	222.	35 00
"	27,	By Cash, Dr. Hewitt's Ex	"	225.	20 00
July	6,	By Cash, Thompson's Dept	"	226.	6 50
"	6,	By Cash, Thompson	"	227.	301 00
"	10,	By Cash, Tribune Co	"	228.	13 50
"	21,	By Cash, Printing	"	236.	418 60
"	21,	By Cash, Printing	"	237.	24 50
"	22,	By Cash, Rhame	"	240.	7 31
"	28,	By Cash, Newton	"	252.	17 60
"	30,	By Cash, Lacy	"	255.	8 32
"	30,	By Cash, Work on Campus	"	256.	51 91
1876.					
July	1,	By Cash, Picture Main Building	"	266.	50 00
"	4,	By Cash, Gilt Frames	"	267.	7 80
1877.					
July	12,	By Cash, Freight	"	272.	6 24
"	30,	By Cash, Printing	"	274.	7 30
Aug.	1,	By Cash	"	276.	15 73
"	1,	By Cash, Postage	"	277.	51 60
"	29,	By Cash, Hardware	"	285.	31 65
"	29,	By Cash, Hardware	"	286.	154 41
"	29,	By Cash, Pens	"	302.	1 25
Sept.	7,	By Cash, Postage	"	303.	16 50
"	4,	By Cash, Rockwood	"	307.	9 70
"	12,	By Cash, Bryant	"	308.	94 62
Oct.	1,	By Cash, Feather Dusters	"	320.	18 50
"	2,	By Cash, Geo. A. Wood	"	324.	5 60
"	4,	By Cash, Express	"	332.	5 95

Sept.	19,	By Cash	Voucher No.	339.		4 90
"	24,	By Cash, Printing	"	343.		49 50
July	1,	By Cash	"	350.		43 50
Aug.	10,	By Cash, Printing	"	352.		2 00
Sept.	17,	By Cash, Printing	"	356.		1 00
"	25,	By Cash, Stechert	"	367.		71 90
Oct.	2,	By Cash, Tin	"	365.		2 50
"	2,	By Cash, Printing	"	366.		21 75
"	10,	By Cash, Regent Harwood's Ex	"	369.		14 50
"	13,	By Cash, Newton	"	370.		20 40
"	19,	By Cash, Freight	"	372.		4 85
"	19,	By Cash, Stationery	"	373.		9 45
"	21,	By Cash, Organ Rent	"	377.		4 00
"	24,	By Cash, Chemical Laboratory	"	378.		11 86
"	25,	By Cash, Telegraphic Apparatus	"	379.		5 10
"	28,	By Cash, Ammunition, Freight	"	380.		2 00
"	28,	By Cash, Insurance	"	381.		345 00
"	29,	By Cash, Laing	"	383.		12 30
"	30,	By Cash, Stationery	"	384.		10 08
"	30,	By Cash, Rent on Show-case for Fair	"	385.		7 00
"	31,	By Cash, Savidge	"	387.		33 74
"	31,	By Cash, Lumber	"	388.		26 08
Nov.	1,	By Cash	"	398.		4 55
"	12,	By Cash, Freight	"	405.		6 75
"	12,	By Cash	"	406.		5 25
"	16,	By Cash, Lacy	"	408.		9 25
"	16,	By Cash, Work on Campus	"	409.		14 63
"	26,	By Cash, Frames for Pictures	"	419.		8 00
Feb.	21,	By Cash, Exchange	"	420.		4 94
Sept.	1,	By Cash, Stamped Envelopes	"	421		16 60
Dec.	3,	By Cash, Savidge	"	426.		24 25
"	5,	By Cash, Omnibus	"	428.		8 00
"	"	By Cash, Prof. Thompson's Dept	"	431.		76 75
		By Cash, Sec. and Treas. salary	"	432.		400 00
		By Cash, Wheaton & Reynold's	"	434.		18 14
		By Cash, Printing	"	435.		14 30
		By Cash, Stationery	"	437.		25 00
		By Cash, Directory	"	448.		3 20
		By Cash, Table	"	449.		9 50
		By Cash, Thompson's Traveling Exp.	"	462.		85 27
		By Cash, Thompson's Examinations.	"	463.		204 73
		By Cash, Lumber		464		19 93
		To balance to Current Expense			$2,358 17	
					$4,076 14	$4,076 14

SALARIES OF FACULTY AND ASSISTANTS.

Cash, G. C. Campbell	Voucher No.	14.	$ 20 00
Cash, Faculty	"	34.	2,215 00
Cash, Clarke	"	35.	75 00
Cash, Savidge	"	36.	15 00
Cash, Currie	"	44.	15 00
Cash, Folwell	"	51.	250 00
Cash, Pritchard	"	61.	5 00
Cash, Faculty	"	77.	2,215 00
Cash, Savidge	"	83.	15 00
Cash, Pritchard	"	84.	5 00
Cash, G. C. Campbell	"	90.	30 00
Cash, Clarke	"	91.	100 00
Cash, Lundeen	"	93.	133 33
Cash, Faculty	"	120.	2,265 00
Cash, Savidge	"	121.	15 00
Cash, Pritchard	"	122.	5 00

May	3,	By Cash, Leonard	Voucher No.	130.		60 00
Mar.	31,	By Cash, Faculty	"	146.		2,265 00
"	31,	By Cash, Savidge	"	147.		15 00
"	31,	By Cash, Pritchard	"	148.		5 00
May	31,	By Cash, Faculty	"	175.		2,265 00
"	31,	By Cash, Mrs. Smith	"	176.		200 00
"	31,	By Cash, Savidge	"	177.		15 00
"	31,	By Cash, Pritchard	"	178.		5 00
June	4,	By Cash, Leonard	"	191.		60 00
"	8,	By Cash, Faculty	"	199.		2,215 00
"	8,	By Cash, Brooks	"	200.		300 00
"	8,	By Cash, Pritchard	"	201.		5 00
"	8,	By Cash, Savidge	"	202.		15 00
"	8,	By Cash, Thompson	"	207.		350 00
"	19,	By Cash, Lundeen	"	218.		200 00
July	21,	By Cash, G. C. Campbell	"	239.		250 00
Aug.	28,	By Cash	"	283.		250 00
"	30,	By Cash, Savidge	"	287.		5 00
Sept.	30,	By Cash, Miss Campbell	"	318.		20 00
"	30,	By Cash, Faculty	"	319.		2,395 00
"	30,	By Cash, Pritchard	"	362.		10 00
"	30,	By Cash, Bowman	"	363.		15 00
Oct.	31,	By Cash, Faculty	"	392.		2,295 00
"	31,	By Cash, Miss Campbell	"	393.		90 00
"	31,	By Cash, Bowman	"	394.		15 00
"	31,	By Cash, Pritchard	"	395.		10 00
Nov.	30,	By Cash, Faculty	"	450.		2,295 00
"	30,	By Cash, Lundeen	"	451.		250 00
"	30,	By Cash, Smith	"	452.		50 00
"	30,	By Cash, Miss Campbell	"	453.		90 00
"	30,	By Cash, Pritchard	"	454.		10 00
"	30,	By Cash, Bowman	"	460.		15 00
Dec.	17,	By Cash, Prof. Thompson's Asst	"	467.		25 00
		To balance to Current Expense			$23,443 33	
					$23,443 33	$23,443 33

EMPLOYES AND WORKMEN.

1877.					
Jan.	31,	By Cash, Mahoney	Voucher No.	40	40 00
"	31,	By Cash, George A. Wood	"	41	14 00
"	31,	By Cash, Bryant	"	42	67 60
"	31,	By Cash, Welles	"	43	14 75
Feb.	27,	By Cash, Welles	"	73	12 50
"	28,	By Cash, Geo. A. Wood	"	80	14 00
"	28,	By Cash, Mahoney	"	81	40 00
"	28,	By Cash, Bryant	"	82	67 60
April,	14,	By Cash, Welles	"	107	14 30
"	30,	By Cash, Bryant	"	124	67 60
"	30,	By Cash, Mahoney	"	125	40 00
"	30,	By Cash, Geo. A. Wood	"	126	14 00
March	31,	By Cash, Bryant	"	150	67 60
"	31,	By Cash, Mahoney	"	151	40 00
"	31,	By Cash, Geo. A. Wood	"	152	14 00
April	20,	By Cash, Rollit	"	159	9 40
May	2,	By Cash, Welles	"	164	15 50
"	3,	By Cash, Bryant	"	167	1 95
"	31,	By Cash, Bryant	"	180	67 60
"	31,	By Cash, Mahoney	"	181	40 00
"	31,	By Cash, Geo. A. Wood	"	182	14 00
June,	1,	By Cash, Welles	"	185	22 35
"	8,	By Cash, Mahoney	"	204	40 00

June	8,	By Cash, Geo. A. Wood	Voucher No. 205			14 00
"	8,	By Cash, Bryant	"	206		67 60
"	12,	By Cash, Bryant	"	210		5 25
August	1,	By Cash, Bryant	"	260		14 00
June	27,	By Cash, Welles	"	268		9 00
July	4,	By Cash, Newton	"	270		11 40
"	7,	By Cash, Geo. A. Wood	"	271		2 25
"	12,	By Cash, Currie	"	273		3 50
Sept.	30,	By Cash, Bryant	"	316		67 60
Oct.	1,	By Cash, Hildreth	"	323		13 62
Sept.	4,	By Cash, Geo. A. Wood	"	353		6 75
"	8,	By Cash, G. B. Thompson	"	354		3 60
Oct.	20,	By Cash, Smith	"	375		9 00
"	31,	By Cash, Newton	"	386		14 00
"	31,	By Cash, Bryant	"	390		67 60
"	31,	By Cash, Geo. A. Wood	"	391		18 00
Nov.	2,	By Cash, Rowley	"	400		11 32
"	2,	By Cash, Hildreth	"	401		27 00
"	26,	By Cash, Mahoney	"	418		50 00
Dec.	3,	By Cash, Newton	"	424		21 60
Nov.	30,	By Cash, Bryant	"	456		67 60
"	30,	By Cash, Geo. A. Wood	"	459		18 00
Sept.	30,	By Cash, Geo. A. Wood	"	360		18 00
		To balance to Current Expense			$1,279 44	
					$1,279 44	$1,279 44

ADVERTISING ACCOUNT.

1877.						
Jan.	9,	By Cash, Anti-Monopolist	Voucher No.	21		$ 65 00
"	31,	By Cash, Farmers Union	"	47		16 66
April	14,	By Cash, "	"	108		16 66
"	24,	By Cash, "	"	161		3 00
June	4,	By Cash, "	"	188		17 84
May	28,	By Cash, Pioneer Press Co.	"	171		4 65
July	23,	By Cash, Country Papers, $3.00 each	"	241		158 10
Feb.	22,	By Cash, Anti-Monopolist	"	245		65 00
May	1,	By Cash, Anti-Monopolist	"	246		65 00
Aug.	9,	By Cash, Farmers Union	"	261		16 66
Sept.	1,	By Cash, Farmers Union	"	291		8 33
"	19,	By Cash, Tribune	"	341		4 80
"	26,	By Cash, St. Paul Newspaper Union	"	344		80 00
"	26,	By Cash, Pioneer Press Co.	"	345		45 00
"	26,	By Cash, Tourist	"	358		5 00
Oct.	16,	By Cash, Farmers Union	"	371		8 33
Nov.	19,	By Cash, Anti-Monopolist	"	412		65 00
		To balance to Current Expense			$645 03	
					$645 03	$645 03

PLANT HOUSE.

1877.						
Feb.		To Cash, Sale of Plants			$ 6 15	
Aug.		To Cash, "			23 35	
		To Cash, "			2 63	
Mar.	22,	By Cash	Voucher No.	99		$ 57 16
		By Cash	"	248		19 55
		By Cash	"	254		117 32
Oct.	2,	By Cash	"	325		35 22
Nov.	2,	By Cash	"	402		25 37
"	16,	By Cash	"	410		21 10
"	30,	By Cash	"	422		26 55
		To balance to Current Expense			270 14	
					$302 27	$302 27

FUEL ACCOUNT.

1877.						
Feb.	10,	By Cash, Armstrong	Voucher No.	52		$ 461 29
"	26,	By Cash	"	76		5 10
April	6,	By Cash, Truesdal	"	102		37 75
"	25,	By Cash, Armstrong	"	113		56 00
June	6,	By Cash, Armstrong	"	193		26 20
"	16,	By Cash, Grove & Rowe	"	214		50 00
July	12,	By Cash, Grove & Rowe	"	229		150 00
Sept.	20,	By Cash, Armstrong	"	342		372 03
Nov.	19,	By Cash, Merriam	"	414		637 40
"	20,	By Cash, Grove & Rowe	"	416		40 00
Dec.	14,	By Cash, Armstrong	"	436		23 50
		To balance to Current Expense			$1,859 27	
					$1,859 27	$1,859 27

CHEMICAL LABORATORY.

1877.						
Sept.	29,	To Cash, Students' Fees			$157 94	
"	29,	To Cash, Chemicals sold			1 63	
"	29,	To Cash, Analyses			16 20	
"	29,	To Cash, Analyses for Geol. Survey			197 00	
June	9,	By Cash, Expense Acct	Voucher No.	311		$372 77
Oct.	4,	By Cash, Dept. of Physics	"	333		1 25
Sept.	10,	By Cash	"	337		36 78
		To balance to Current Expense			38 03	
					$410 80	$410 80

REPAIRS ACCOUNT.

1876.					
Dec.	30,	By Cash, Bowman	Voucher No.	8	27 40
1877.					
Jan.	6,	By Cash, Swett	"	11	5 57
1876.					
Dec.	21,	By Cash, Pomeroy & Co.	"	19	55 20
"	22,	By Cash, Pickett	"	20	5 00
1877.					
Jan.	13,	By Cash, Cauvet	"	22	45 84
"	13,	By Cash, Cauvet	"	23	7 61
"	31,	By Cash, Bowman	"	46	23 60
Feb.	17,	By Cash, Chambers & Co.	"	59	9 00
"	28,	By Cash, Bowman	"	85	23 45
1876.					
Dec.	21,	By Cash, Spink	"	94	60
1877.					
April	7,	By Cash, Wheaton & Reynolds	"	104	6 00
May	21,	By Cash, Bowman	"	145	18 20
March	31,	By Cash, Bowman	"	153	19 50
June	2,	By Cash, Paterson	"	187	5 00
"	21,	By Cash, Bowman	"	219	14 80
July	15,	By Cash, Bowman	"	231	37 71
"	15,	By Cash, Herzog	"	232	31 25
"	18,	By Cash, Herzog	"	234	15 50
June.		By Cash, Bowman	"	238	8 50
July	23,	By Cash, Paterson	"	242	4 00
"	25,	By Cash, St. Anthony Iron Works	"	243	83 11
"	30,	By Cash, Parker	"	257	43 70
August	9,	By Cash, Perkins	"	262	3 50
"	9,	By Cash, Perkins	"	263	10 21
"	23,	By Cash, Pickett	"	278	12 00
"	25,	By Cash, Bowman	"	279	26 60
"	28,	By Cash, Mahoney	"	282	16 50
"	30,	By Cash, Lumber	"	288	38 03

Sept.	3,	By Cash, Perkins	Voucher No.	298		11 58
"	5,	By Cash, Bowman	"	301		79 72
"	29,	By Cash, Perkins	"	312		51 00
"	29,	By Cash, Savidge	"	313		14 99
"	26,	By Cash, Savidge	"	314		25 61
Oct.	1,	By Cash, Savidge	"	321		38 00
"	1,	By Cash, Bowman	"	322		21 25
"	4,	By Cash, Cauvet	"	328		1 99
Sept.	27,	By Cash, Cauvet & Ried	"	346		20 53
Oct.	27,	By Cash	"	382		38 49
Nov.	17,	By Cash, Smith	"	411		16 74
"	19,	By Cash	"	413		3 00
Dec.	4,	By Cash, Columns	"	427		32 85
		To Balance to Current Expenses			$953 13	
					$953 13	$953 13

EXPERIMENTAL FARM.

Dr.

1876.						
Feb.	8,	To Cash, Farm Products			$58 45	
Aug.		To Cash, Farm Products			171 61	
"		To Cash, Farm Products			131 97	

Cr

Jan.	13,	By Cash, Hern	Voucher No.	24.		5 00
"	13,	By Cash, Horse-shoeing	"	25.		8 65
"		By Cash, Shatto & Christie	"	27.		5 05
"	15,	By Cash, Scott	"	28.		6 00
"	31,	By Cash, Scott	"	39.		50 00
"	31,	By Cash, Moore	"	45.		2 90
"	22,	By Cash, Brown & Greeley	"	60.		6 80
1876.						
April	8,	By Cash, Plow	"	62,		4 00
1877.						
Feb.	28,	By Cash, Scott	"	78.		50 00
Mar.	22,	By Cash, Expense Account	"	97.		212 28
April	5,	By Cash, Scott	"	101.		50 00
July	14,	By Cash, Eustis	"	230.		50 00
"	28.	By Cash, Campbell	"	251.		51 75
"	30.	By Cash, Expense Account	"	253.		568 37
Aug.	1,	By Cash, Bryant	"	258.		33 25
"	1,	By Cash, Barrett	"	259.		33 50
"	27,	By Cash, Campbell	"	280.		10 00
Sept.	3,	By Cash, Barrett	"	292.		14 83
"	3,	By Cash, Bryant	"	293.		17 50
"	3,	By Cash, Bryant	"	294.		17 50
"	3,	By Cash, Barrett	"	295.		26 70
"	3.	By Cash, Williams	"	296.		13 75
"	12,	By Cash, Eustis	"	310.		100 00
"	30,	By Cash, Eustis	"	315.		50 00
Oct.	4,	By Cash, Barrett	"	327.		13 13
Sept.	19,	By Cash, Richards & Cooley	"	340.		14 98
Oct.	31,	By Cash, Eustis	"	389.		50 00
Nov.		By Cash, Expense Account	"	407.		276 26
"	30,	By Cash, Eustis	"	457.		50 00
		To Balance to Current Expense			1,430 17	
					$1,792 20	$1,792 20

LIBRARY AND READING ROOM.

1877.						
		To Cash, 2 Vols. Cyclopedia			$17 20	
		To Cash, 4th Vol. Cyclopedia			8 60	
		To Cash, Dictionary			3 00	
Jan.	9,	By Cash, Papers and Magazines	Voucher No.	15		$ 93 10
"	9,	By Cash, Papers	"	16		5 00
"	31,	By Cash, Campbell	"	37		20 00
April	14,	By Cash, Campbell	"	106		20 00
"	16,	By Cash, Guth & Breest	"	110		33 60
May	2,	By Cash, Currie	"	128		16 60
"	5,	By Cash, Campbell	"	134		15 00
"	14,	By Cash, Guth	"	141		44 80
April	23,	By Cash, Paper	"	160		1 60
May	3,	By Cash, Express	"	165		3 75
"	31,	By Cash, Campbell	"	179		15 00
June	6,	By Cash, Currie	"	194		10 35
"	12,	By Cash, Miss Rollit	"	211		14 25
"	16,	By Cash, Binding books	"	216		6 60
"	27,	By Cash, Campbell	"	269		11 10
Sept.	3,	By Cash, Campbell	"	305		5 10
"	4,	By Cash, Rockwood	"	306		5 77
"	17,	By Cash, Binding books	"	309		21 20
Feb.	10,	By Cash, Books	"	50		255 00
April	28,	By Cash, Books	"	116		220 90
July	27,	By Cash, Books	"	247		230 50
Sept.	30,	By Cash, Campbell	"	317		50 00
Oct.	3,	By Cash, Books	"	326		391 94
Aug.	5,	By Cash, Campbell	"	351		9 95
Sept.	10,	By Cash, Campbell	"	355		7 58
"	30,	By Cash, Miss Rollit	"	359		13 50
Oct.	31,	By Cash, Campbell	"	396		50 00
Nov.	1,	By Cash, Miss Rollit	"	399		19 42
"	3,	By Cash, Library Journal	"	403		5 00
Dec.		By Cash, Tappan Library	"	423		1,775 25
"	5,	By Cash, Miss Rollit	"	429		11 17
"	7,	By Cash, Books	"	433		23 00
May	2,	By Cash, Books	"	438		5 60
"	15,	By Cash, Books	"	439		5 00
June	4,	By Cash, Books	"	440		8 35
"	11,	By Cash, Books	"	441		11 20
"	18,	By Cash, Books	"	442		7 45
July	21,	By Cash, Books	"	443		10 00
Sept.	12,	By Cash, Books	"	444		5 00
"	10,	By Cash, Books	"	445		8 10
Nov.	8,	By Cash, Books	"	446		4 50
Dec.	15,	By Cash, Books	"	447		2 80
Nov.	30,	By Cash, Campbell	"	458		50 00
Dec.	7,	By Cash, Books	"	430		159 07
"	17,	By Cash, Books	"	461		54 20
		To balance to Current Expense			3,708 50	
					$3,737 30	$3,737 30

MUSEUM.

Oct.	4,	By Cash	Voucher No.	330		23 06
1876.						
Nov.	14,	By Cash	"	347		111 36
1877.						
May,		By Cash	"	348		324 33
Oct.	6,	By Cash	"	349		26 88
"	10,	By Cash, Minerals	"	367		100 00
Nov.	8,	By Cash, Herrick	"	404		17 40
		To Balance to Current Expense			$603 03	
					$603 03	$603 03

GEOLOGICAL SURVEY ACCOUNT.

1877. July		To Cash			$2,000 00	
		By Balance at last statement				$4,310 55
1876. Dec.	19,	By Cash, Whitman	Voucher No.	17		30 00
1877. Jan.	12,	By Cash, Whitman	"	29		150 00
"	31,	By Cash, Winchell	"	38		200 00
Feb.	9,	By Cash, Analyses	"	49		60 00
"	28'	By Cash, Winchell	"	79		200 00
April	25,	By Cash, Analyses	"	114		194 00
March	31,	By Cash, Winchell	"	149		200 00
April	30,	By Cash, Winchell	"	123		200 00
May	31,	By Cash, Winchell	"	174		200 00
June	8,	By Cash, Winchell	"	203		200 00
"	19,	By Cash, Expense account	"	217		100 00
July	16,	By Cash, Tribune Co	"	233		12 00
"	19,	By Cash, Herrick	"	235		50 00
Aug.	14,	By Cash, Analyses	"	264		75 00
"	18,	By Cash, Expense account	"	265		25 00
July	31,	By Cash, Winchell	"	275		200 00
Aug.	31,	By Cash, Winchell	"	289		200 00
"	28,	By Cash, Herrick	"	284		50 00
Sept.	1,	By Cash, Winchell	"	290		100 00
"	3,	By Cash, Rhame	"	299		16 50
Oct.	4,	By Cash	"	329		55 85
"	4,	By Cash	"	331		33 14
"	5,	By Cash, Herrick	"	334		50 00
"	5,	By Cash, Herrick	"	335		10 00
Sept.	30,	By Cash, Winchell	"	361		200 00
Oct.	31,	By Cash, Winchell	"	397		200 00
Nov.	30,	By Cash, Winchell	"	455		200 00
		To Balance			$5,522 04	
					$7,522 04	$7,522 04

BUILDING ACCOUNT.

		To balance at last statement			$7,807 54	
1876. Dec.	30,	By Cash, Prof. Campbell's room	Voucher No.	9		$ 15 90
1877. Jan.	26,	By Cash, Bisbee & Moses	"	32		194 71
Mar.	22,	By Cash	"	98		15 69
May	18,	By Cash, Osborn	"	144		7 85
July	27,	By Cash, Lyons	"	249		20 75
"	27,	By Cash, Lyons	"	250		30 30
Aug.	27,	By Cash, Beckman	"	281		30 75
Sept.	3,	By Cash, Lyons	"	297		26 50
"	1,	By Cash, Brick	"	304		8 00
		Balance				7,457 09
					$7,807 54	$7,807 54

HEATING AND FURNISHING ACCOUNT.

		To balance at last Statement			$2,027 65	
1877. Jan.	15,	By Cash, Gas Fixtures	Voucher No.	30		$ 9 65
"	15,	By Cash, Drain	"	31		3 00
Feb.	27,	By Cash, Chairs	"	72		36 60
"	26,	By Cash, Work in Chemical Lab	"	75		42 65
March	6,	By Cash, Cauvet	"	88		22 91
"	5,	By Cash, Benjamin	"	95		31 83

April	7,	By Cash, Butler	Voucher No. 103		85 02
"	7,	By Cash, Wheaton & Reynolds	" 105		24 67
"	17,	By Cash, Museum	" 111		35 00
"	27,	By Cash, Museum	" 115		16 30
"	28,	By Cash, Museum	" 117		23 44
"	28,	By Cash, Museum	" 119		22 67
May	4,	By Cash, Museum	" 131		19 38
"	4,	By Cash, Museum	" 132		26 03
"	12,	By Cash, Moore	" 137		8 50
"	12,	By Cash, Moore	" 138		65 00
"	14,	By Cash, Museum	" 142		66 21
"	18,	By Cash, Museum	" 143		90 97
April	24,	By Cash, Museum	" 162		12 28
May	23,	By Cash, Pomeroy & Co	" 170		2 88
June	27,	By Cash, Museum	" 223		44 50
"	27,	By Cash, Museum	" 224		20 91
July	26,	By Cash, Museum	" 244		11 79
Sept.	3,	By Cash, Stetson & Nelson	" 300		14 63
Feb.	29,	By Cash, Parrott	" 336		350 00
Sept.	19,	By Cash, Gardiner	" 338		4 50
Oct.	1,	By Cash, Carpeting	" 364		3 82
"	10,	By Cash, Museum Locks	" 368		17 55
"	19,	By Cash, Museum Cases	" 374		100 00
"	20,	By Cash, Matting	" 376		229 36
Nov.	19,	By Cash, Talbert & White	" 415		42 38
"	21,	By Cash, Hardware	" 417		37 11
Dec.	3,	By Cash, Stoves	" 425		55 50
"	17,	By Cash, under Winchell	" 465		4 75
"	17,	By Cash, Museum Cases	" 466		200 00
		By balance			245 86
				$2,027 65	$2,027 65

SUMMARY OF BALANCES.

Building Account—		
To Balance	$7,457 09	
Heating and Furnishing—		
To Balance	245 86	
Experimental Farm Fund—		
To Balance	671 87	
Land Sales Fund....—		
To Balance	813 42	
Geological Survey—		
By Balance		$5,522 04
Current Expense—		
By Balance		6,227 08
By Balance	2,560 88	
	$11,749 12	$11,749 12

ELEVENTH ANNUAL REPORT

OF THE

PRESIDENT

OF THE

UNIVERSITY OF MINNESOTA,

TO

THE BOARD OF REGENTS.

1877-8.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 1st, 1877.

Hon. H. H. Sibley, President of the Board of Regents:

SIR: I have the honor herewith to transmit the eleventh Annual Report of the condition and progress of the University.

I have the honor to be, Sir,
Very respectfully,
Your obedient servant,
WILLIAM W. FOLWELL,
President.

REPORT OF THE

PRESIDENT OF THE UNIVERSITY.

To the Honorable, the Board of Regents:

The University year 1876–7, began on the 18th day of September, 1876, and ended June 22d, 1877. The dates of the recesses and legal holidays, together with the names and residences of the officers and students for the year, may be seen in the Annual Calendar for the year.

CONDITION AND PROGRESS.

ATTENDANCE.

The following tables show the enrollment and attendance of students for the year:

SUMMARY, 1876–7.

COLLEGE OR DEPARTMENT.	CLASS.	Gentlemen.	Ladies.	Totals.
Science, Literature and the Arts	Graduates	1	1	2
	Senior	14	4	18
	Junior	11	2	14—34
Mechanic Arts	Senior	1	....	1
	Junior	2	....	2—3
Agriculture. Advanced Course	Junior	1	....	1
Agriculture. Elementary Course	III. and IV.	1	....	1—2
Collegiate Department	First	23	14	37
	Second	18	12	30—106
	Third	47	18	65
	Fourth	51	22	73—138
	Special	40	19	59—59
Totals		210	93	*303

*In the Calendar for 1876-7. one name was counted twice, by mistake, making this 4.

OR, BY CLASSES ONLY.

Graduates	2	
Seniors—of all Departments	19	
Juniors—of all Departments	17	
Sophomores—First Class, Collegiate Department	37	
Freshmen—Second Class, Collegiate Department	31	—106
Preparatory { Third Class, Collegiate Department	65	
Preparatory { Fourth Class, Collegiate Department	73	—138
Special	59	— 59
Total		303

COLLEGE OF SCIENCE, LITERATURE, AND THE ARTS.

CLASS.	COURSE.	Gentlemen	Ladies.	Total.
GRADUATES		1	1	2— 2
SENIOR	Classical	9		9
	Scientific	4		4
	Modern	1	4	5—18
JUNIOR	Classical	6		6
	Scientific	4	2	6
	Modern	1	1	2—14
Totals		26	8	34

COLLEGE OF THE MECHANIC ARTS.

CLASS.	COURSE.	Gentlemen	Ladies.	Total.
SENIOR	Architecture	1		1
JUNIOR	Civil Engineering	2		2
Totals		3		3

COLLEGE OF AGRICULTURE.

Advanced Course, Junior Class, Gentlemen	1
Elementary Course, Gentlemen	1

COLLEGIATE DEPARTMENT.

CLASS.	COURSE.	Gentlemen	Ladies.	Total.
FIRST	Classical	9	1	10
	Scientific	12	7	19
	Modern	2	6	8
		23	14	37
SECOND	Classical	5	2	7
	Scientific	11	4	15
	Modern	2	6	8
		18	12	30
THIRD	Classical	18	1	19
	Scientific	22	2	24
	Modern	7	15	22
		47	18	65
FOURTH	Classical	12	....	12
	Scientific	31	....	31
	Modern	8	22	30
		51	22	73
SPECIAL STUDENTS	....	40	19	59
Totals	....	179	85	264

Two hundred and seventy-five (275) students were registered as residents of Minnesota, the following counties being represented:

Anoka, 1; Becker, 3; Blue Earth, 8; Brown, 5; Carver. 5; Crow Wing, 1; Dodge, 6; Douglas, 7; Fillmore, 19; Freeborn, 2; Goodhue, 9; Hennepin East, 47—city 42, county 5; Hennepin West, 78—city 51, county 28; Kanabec, 1; LeSueur, 4; Meeker, 2; Mower, 1; Nicollet, 6; Nobles, 1; Olmsted, 3; Ramsey, 16; Rice, 4; Saint Louis, 2; Scott, 1; Sibley, 1; Stearns, 6; Stevens, 1; Steele, 6; Wabasha, 17; Washington, 12; Waseca, 1; Winona, 8; Wright, 7. Thirty-three counties.

Eighteen (18) students were registered from other States and countries, as follows:

Illinois, 1; Iowa, 3; Maine, 3; Michigan, 1; New Hampshire, 1; New York, 1; Ohio, 2; Wisconsin, 4; Nova Scotia, 2.

One hundred and forty-four were engaged in some remunerative employment, and seventy are believed to have earned their whole support. Eighty-seven had been teachers.

THE WORK OF THE YEAR.

The attention of this Board is respectfully called to the following exhibit of the kinds and amounts of work performed in the several departments of instruction, as reported by the respective officers in charge:

Subjects.	Instructor.	Class.	No. of Exercis's	No. of Students	Term.
MATHEMATICS.					
Algebra, Elementary.........	Thompson.	Fourth.	40	34	I.
Algebra (advanced)..........	Thompson, Lundeen.	Fourth.	65	70	II.
Algebra "	Thompson, Lundeen.	Third.	55	60	III.
Solid Geometry	Thompson.	Second.	13	42	I.
Plane Trigonometry..........	"	Second.	45	43	I.
Spherical Trigonometry......	"	Second.	30	40	I.
Conic Sections................	"	Second.	40	34	III.
Analytical Geometry.........	"	First.	20	30	II.
Surveying	Peck.	Second.	24	34	III.
Differential Calculus..........	Thompson.	Junior.	58	5	I.
Integral Calculus............	"	Junior.	50	5	II.
Elementary Astronomy.......	Lundeen.	Fourth.	50	21	III.
Descriptive Astronomy.......	Thompson.	First.	40	31	III.
Plane Geometry..............	Clarke, J. S.	Third.	60	72	I.
Practical Astronomy.........	Thompson.	Senior.	41	4	III.
CHEMISTRY.					
Analytical Chemistry.........	Peckham.	First.	31 d.*	12	I.
" "	"	Junior.	33 d.	2	I.
" "	"	Senior.	32 d.	2	I.
" "	"	First.	22	10	III.
" "	"	Senior.	55	2	II.
" "	"	Junior.	60	2	III.
		Senior.	60	1	III.
General Chemistry............	"	Second.	48	34	II.
Applied Chemistry—Lectures	"	Second.	41	24	III.
" " —Recitations.	"	Second.	18	24	III.
Analytical Chemistry.........	"	Graduate.	60	2	III.
" "	"	Specials in Med. Chem.	60	3	III.
" "	"	Specials in Assaying.	....	2	III.
PHYSICS.					
Mechanical Physics...........	Rhame.	First.	55	12	I.
Molecular Physics............	Peck.	Second.	54	34	I.
Natural Philosophy...........	Peck.	Third.	54	24	I.
GEOLOGY.					
Dynamical Geology, 1st Sec..	Winchell.	Third.	53	25	II.
" " 2d Sec...	"	Third.	53	38	II.
Mineralogy and Lithology....	"	Junior.	61	8	II. &c.
Historical Geology............	"	Junior.	37	5	III.
" " —Lectures	"	Junior.	18	5	III.

* Double hours.

Subjects.	Instructor				Term.
BOTANY.					
1st Section.	Leonard.				III.
2d Section	"				III.
ZOOLOGY	Lacy.				II.
"	"				III.
PHYSICAL GEOGRAPHY.	Lacy.				I.
ENGLISH, &c.					
Elements of Criticism	Marston.				I.
English Literarure	"				I.
" "	"				II
" "	"				III.
Logic	Folwell.				I.
Rhetoric	Marston.				III.
Anglo-Saxon	"				I.
English Composition	Mrs. Smith.				I.
Study of Words	"				II.
Rhetorical Exercises (public)	Marston.				I. II. III
" " (class)	"				I. II III
" " (class)	"				II III
Rehearsals	"	Senior & Jun.	250	29	I. II III
"	"	First.	60	31	II. III.
Essays and Orations criticised	"	Senior & Jun.	160	32	I. II. III
Essays criticised	"	First.	95	31	II. III.
Lectures	"	Junior and I.	14	47	I. III.
Rhetorical Exercises	Laing.	First.	8	33	I.
Essays corrected	"	First.	66	32	I.
Elocution	"	Third	10	62	I.
"	"	Third, 3 §§.	30	60	II.
" —Lectures	"	Third.	4	60	II.
Rhetorical Exercises	"	Tourth.	21	67	III.
Essays corrected	"	Fourth.	208	67	III.
" "	Mrs. Smith.	Fourth.	650	80	I.
GERMAN.					
Minna von Barnhelm	Moore.	Second.	55	19	I.
Faust.	"	Junior.	54	4	I
German Grammar	"	Third.	55	27	I.
" "	"	Jun. and Third	55	26	I.
Hermann and Dorothea	"	Second.	50	20	II.
Grammar and Reader	"	Third	50	22	II.
Wilhelm Tell and Germ. Lit.	"	Senior & Jun.	30	5	II.
Grammar and Reader	"	Jun and Third	50	27	II.
Egmont and History	"	Junior.	36	5	III.
Wilhelm Tell	"	Second.	55	18	III.
Grammar and Reader	"	Third.	55	23	III.
" "	"	Jun. and Third	55	22	III.
FRENCH.					
French Drama.	Campbell.	Junior.	60	5	II
" Classical Prose.	Campbell.	Junior.	60	4	III.
" Grammar, &c	Laing.	First.	50	33	I.
" Reader, &c	"	First.	54	20	II
" Selections	"	First.	56	26	III.
ITALIAN.					
Grammar, &c	Laing.	Senior	50	5	II.
Reading	"	Senior.	15	3	III.
LATIN.					
Plautus	Brooks.	Senior.	55	13	I.
" Papers	"	Senior.	26	13	I.
Horace	Hutchinson.	First.	60	20	I.
" Papers	"	First.	20	20	I.
Cicero	Clarke, J. B.	Third.	41	29	I.
Cæsar	Clarke, J. S.	Third.	55	19	I
" Papers	"	Third.	28	19	I.
Grammar and Reader	Clarke, J. B.	Fourth.	41	28	I.
sar	Clarke, J. S.	"	60	21	I.
" Papers	"	"	42	21	I.
[illegible]	Brooks.	Junior.	57	9	II.

Subjects.	Instructor.	Class.	No. of Exercis's	No. of Students	Term.
LATIN, (*Continued.*)					
Horace	Clarke, J. S.	First.	51	18	II.
Livy	"	Second.	53	27	II.
Virgil	"	Third.	52	34	II.
" Papers	"	"	34	34	II.
"	"	"	52	12	II.
" Papers	"	"	12	12	II.
Cæsar	Clarke, J. B.	Fourth.	55	25	II.
Grammar and Reaeer	"	"	55	26	II.
Cicero, de Senectute & Plautus	Brooks.	Junior.	57	8	III.
Livy	Clarke, J. S.	Second.	53	20	III.
Cicero	Hutchinson.	Third.	54	12	III.
Virgil	Clarke, J. S.	"	53	26	III.
" Papers	"	"	26	26	III.
Cæsar	"	Fourth.	53	17	III.
Cicero	Hutchinson.	"	55	18	III.
GREEK.					
Plato	Brooks.	Junior.	57	6	I.
" Lectures	"	Junior.	4	6	I.
" Papers	"	Junior.	25	6	I.
Homer	Hutchinson.	Second.	56	4	I.
" Papers	"	"	4	4	I.
Xenophon	"	Third.	56	21	I.
Grammar and Reader	"	Fourth.	55	9	I.
Aristotle	Brooks.	Senior.	55	9	II.
" Lectures	"	Senior.	3	9	II.
Thucydides	Hutchinson.	First.	54	9	II.
" Papers	"	"	9	9	II.
Homer	"	Second.	53	4	II.
" Papers	"	"	4	4	II.
Xenophon	"	Third.	53	21	II.
" " Papers	"	"	21	21	II.
Grammar and Reader	"	Fourth.	54	12	II.
Æschylus	Brooks.	First.	56	8	III.
" Lectures	"	"	2	8	III.
" Papers	"	"	32	8	III.
Thucydides	Hutchinson.	Second.	55	6	III.
Grammar and Reader	"	Fourth.	55	7	III.
PHILOLOGY (theoretical)	Campbell.	Junior.	24	13	II.
MENT. & MOR. PHILOSOPHY.					
History of Philosophy	Campbell.	Senior.	40	16	I.
Ontology	"	Senior.	25	16	I.
Ethics	"	Senior.	40	16	II.
Evidences of Christianity	"	Senior.	20	16	II.
Natural Theology	"	Senior.	16	17	III.
Psychology	"	Junior.	60	13	III.
Psychology	"	Senior.	60	4	III.
Natural Theology	"	Graduate.	16	1	III.
HISTORY.					
English History	Laing.	Fourth.	50	32	I.
General History	"	Fourth.	58	67	III.
Civil Government	"	Senior.	54	10	II.
" " Lectures	"	Senior.	5	10	II.
Mediæval History	Mrs. Smith.	First & Second	55	6	II.
Modern History	"	First & Second	57	4	III.
Historical Papers	"	First & Second	34	6	II. & III
HISTORY OF CIVILIZATION.					
Guizot	Folwell.	Junior.	33	13	II.
POLITICAL ECONOMY.					

Subjects.	Instructor.	Class.	No. of Exercis's	No. of Students	Term.
SANITARY SCIENCE.					
Lectures	Hewitt.	Senior.	6	16	III.
Physiology	Peck.	Fourth.	55	50	III.
INDUSTRIAL DRAWING.					
Descriptive Geometry	Rhame.	First.	55	13	II.
Projection Drawing	"	Second.	53 d.	12	II.
Elementary Drawing	Peck.	Third.	53 d.	25	II.
" "	"	Third.	53 d.	33	II.
Free Hand Drawing	Rhame.	Fourth.	58 d.	30	III.
Desc. Geom. and Perspective	"	First.	58 d.	11	III.
CIVIL ENGINEERING, &c.					
Engineering	Rhame.	Junior.	45	2	I.
Strength of Materials	"	Senior.	55	1	I.
Analytical Mechanics	"	Junior.	58	1	II.
Hist. of Architecture	"	Senior.	40	1	II.
Applied Mechanics	"	Junior.	58	2	III.
AGRICULTURE.					
How Crops Grow	Lacy.	Second.	53	1	II.
How Crops Feed	"	Second.	51	1	III.
Farm Drainage	"	Second.	30	1	III.
MILITARY TACTICS.					
School of the Soldier	Lundeen.	First.	10	20	I.
" " "	"	Second.	....	18	
" " "	"	Third.	....	41	
" " "	"	Fourth.	....	43	
Manual of Arms	"	First.	18	13	II.
" "	"	Second.	....	22	
" "	"	Third.	....	39	
" "	"	Fourth.	....	43	
School of Comp'y & Battalion	"	First.	15	9	III.
" " "	"	Second.	....	15	
" " "	"	Third.	....	32	
" " "	"	Fourth.	....	31	

*Double hours.

It will be seen that the courses of study authorized by the Board have been carefully conformed to.

The first term of the year began September 18, 1876, and ended December 14, 1876. The second term began December 19, 1876, and ended March 8, 1877. The third term began March 13, 1877, and ended with the Commencement, June 7, 1877. The whole number of working days was 180.

The above tables do not include the examinations, nor the revision and correction of examination papers, and many other written exercises. In some departments this work amounts in the aggregate to many days' works; for instance, in the department of Mathematics, it is within bounds to say that 32½ days of 6 hours each, were necessarily occupied in inspecting, recording and reporting examinations. Still there is probably no means other than such an exhibit as the above by means of which the Board can judge of the manner in which their officers are severally employed.

At this point it is convenient to direct the attention of the Board to the circumstance that the labor of conducting the entrance examinations now falls upon a certain few members of the corps of instruction. It would be equitable if this duty were to be taken into consideration in the fixing of salaries; and I would suggest as

a matter for consideration, the propriety of forming the professors concerned into an examining committee under the authority of the Board, and assigning definite compensation for the work. It may be assumed that the professor's duty as such begins when the student has gained his admission under the conditions established by the Board.

COURSES OF STUDY.

Agreeably to the desire of the Board, the General Faculty devoted during the University year a great deal of time and labor to the revision of the courses of study in the various departments and colleges. The new schedule may be seen in full in the calendar for the year 1876-7. The most of the changes consist in transpositions of work from term to term in such a way as to distribute the work of the teaching force more equally and conveniently with reference to class rooms and apparatus.

The sphere of History is considerably enlarged at the expense of Mathematics; that of English at the expense of Latin. The department of French has been somewhat restricted, in order to save the necessity of employing an additional professor.

In general the arrangement of the courses and the studies is such that a considerable increase in the number of students will not require any material addition to the teaching force, an expectation fully justified by the experience of the past three months. It is believed that the present courses of study now offered by you to the youth of Minnesota will compare favorably with those of similar institutions, and it is a fortunate circumstance that they have the cheerful approval of the officers charged by you with giving the instruction.

"Summer Courses."

At this point I desire to ask attention of the Board to an important project brought forward at the last annual convention of the State Teachers' Association. I cannot, perhaps, do better than to insert a brief extract from the annual address of the President, Professor Wm. Gorrie, of Stillwater:

"The earnest teacher never loses sight of opportunities for his own improvement. In the steady advancement of science and the progress of thought, it behooves him to keep even pace or be left ignominiously behind. A teacher behind the times in methods of instruction or in a knowledge of the sciences is fit only to be placed with the fossils of the past. The pioneers and explorers in the fields of thought are few, but the number who will accept the results of their toil are great. Some one has said that "our country especially needs to-day men and women of convictions." This is a fact. The times and the the cause of education demand thinkers—men and women who reach out for facts, who delight by patient, persevering industry to reduce theories to laws and to comprehend and utilize the facts in nature and science. Realizing this, energetic enthusiastic teachers, in other states, have arranged for special courses of study during vacations, where instruction in the most modern phase of science can be obtained. Botanical or geological

expeditions are projected and enjoyed, and profitable recreations they are. Classes are formed to whom the latest chemical discoveries and methods of analysis are disclosed. Vacation tours are projected to visit places of practical interest to the teacher. Schools in drawing, mining and metallurgy are afforded. Now we in Minnesota can scarcely afford to go East to enjoy these advantages. What shall we do? sit still and let others surpass us, or go to work and from our own resourses build up the best of the kind we can at home? I believe the time has come for the incipiency of such a movement, and that it devolves upon us to take measures leading to the establishment of such opportunities for further improvement as we all need and of which many would gladly avail themselves.

I would respectfully submit the suggestion herein made to the consideration of the Board. I have no doubt that special courses of instruction in Chemistry, Botany, Physics, Geology and other subjects could be carried on during the summer vacation without material expense to the University and to the great advantage of the teachers of the State.

ADMISSION.

The whole number of applicants for admission in 1876-7 was one hundred and thirty-four (134). The whole number fully examined was one hundred and twenty-four (124), of whom sixteen (16) failed to pass. Seven of these, however, afterwards obtained admission, by making up deficiencies.

At the beginning of the year fourteen (14) applicants were rejected under the operation of the resolution of the Board of Regents, passed May 10th, 1876, excluding residents of high school districts from the preparatory classes. Five (5) of these, however, having been examined for advanced standing were, upon recommendation of their superintendent, admitted in the second term.

The whole number of new students admitted to instruction was one hundred and six. They selected their courses of study as follows:

Classical Course—Gentlemen	18	Ladies	2—20
Scientific Course—Gentlemen	31	Ladies	0—31
Modern Course—Gentlemen	10	Ladies	34—43
Selected Studies—Gentlemen	13	Ladies	8—21

The average per cents of merits for the *elementary* branches, in which all applicants are examined were as follows:

Reading, 77; Writing, 71; Spelling, 77; English Grammar, 66; Arithmetic, 71; Elementary Algebra, 56; Geography, 74; United States History, 67; Average, 70.

The existing policy of the Board in regard to admission continues to give excellent results. There is no further interference with the work of the high schools and the liberality of the Board in continuing the fourth class reaches precisely the class of persons intended to be benefitted, namely the youth of those districts which have no high schools in which to obtain their preparation for the

University. It is obvious, however, that the University can not and ought not to carry on this preparatory work indefinitely. It is equally apparent that no part of it should at any time be so suddenly or prematurely discontinued as to leave an unbridged gulf between the University and the schools. As the matter now stands the University education with all advantages and incidents is actually within the reach of *all* the youth of the State who in any practical sense desire it. This seems to me a most noble privilege. Should the Board be forced to demolish those stepping stones which they have erected and so long maintained for reaching the offered advantages and honors, the University would cease to be accessible to all and remain open practically only to the few and the fortunate. Could there be a stronger argument invented to prove the necessity of thoroughly and completely organizing the education of a State?

Such then would be the effect of a premature curtailment of preparatory work by the University, upon the present generation of youth in our State. The effect on the University itself would be injurious in the following ways: (1) the attendance would be cut down excessively; (2) the standard of scholarship would inevitably sink below a reputable limit; and (3) more probably both of these results would supervene.

What the opinions and practice of college boards and faculties in neighboring states, dealing with the same problem, under conditions more favorable than ours, are and have been, may be seen by a reference to the statistics given in the annual report for 1875,* page 48.

As already remarked, the University cannot carry this load of preparatory instruction indefinitely; the mischief of a premature discontinuance of it has been pointed out. The practical question then is how to secure the giving of preparatory instruction elsewhere. It ought here to be remarked that so long as the University continues without warning and announcement of intention to cease from giving preparatory instruction, there are those who, able and competent to carry on such work, will refrain from doing so. There are probably actual instances in which a part or a whole of the work of a high school has been actually abolished, because the few scholars intending to pursue a college course could in that case get their preparation at the University.

It is therefore essential that the Board fix upon definite times in the future for dropping the remaining grades of preparatory work.

It is equally essential that provision be made for preparatory instruction elsewhere. These two things must go together or loss and damage will be the result. As managers of one of the constituent elements of a system of public education this Board will

*"Only 8 of the 118 colleges and universities * * of the nine states [of the Mississippi Valley north of the Ohio River] report no preparatory students. The colleges of Illinois, Indiana, Nebraska and Wisconsin, without exception, report preparatory students. Four only, out of the 32 colleges of Ohio do not; of the remaining states, Iowa, Kansas, Michigan and Missouri, but one college in each reports no preparatory students. Of all the state universities, that of Michigan alone has rid herself of the burden of fitting her own candidates for admission."

naturally recur in the first instance to the high schools of the State to assume the work of preparing students for the University. But the high schools are municipal establishments supported in the main by local taxation. They may instruct the youth of their own districts, but are under no obligation to receive students from the country. Undoubtedly they would receive and instruct outside students if they were paid for it. The first step then to be taken is to secure from the legislature a permanent appropriation of sufficient amount to pay the tuition of country and village youth in the high schools. Two years ago a bill to effect this object failed, at the close of the session, in the lower house. Pending the consideration of the bill a memorandum of reasons for its passage was laid upon the desks of the members. I would respectfully offer that document to be printed as a part of this report, because I think it clearly summarizes the considerations which should influence the Board and the legislature.

MEMORANDUM.

Reasons for Encouraging Higher Education in the State, as Proposed by Senate File No. 305.

I. In all civilized countries, higher education is encouraged and provided for by statesmen, not only as essential to the well-being of the state, but because of the stimulus it gives to other educational work.

Universities, colleges and polytechnic schools call into being and activity numerous "secondary schools," variously called high schools, academies, gymnasia, etc. These schools draw from a multitude of primary schools. The common schools are best where they are supplemented by prosperous middle schools, and these, in turn, are quickened and elevated by the vitalizing influences of the universities and other institutions of superior education.

Instance: The German Empire, population 41,060,695; square miles, 212,091.
Universities and polytechnic schools, 21; having 2,159 teachers and 23,351 students.
Secondary schools.... .. .... 1,041; 120,000 "
Primary schools ....60,000; " 109,000 " 6.000,000 "

These institutions form substantially the system of public instruction, organized and encouraged by the States of the Empire.

II. In America this natural and necessary gradation of schools has always been recognized.

In the older States are found, (1) the common schools, (2) the academies, (and latterly, high schools,) (3) the colleges. In the newer States, the system is composed of, (1) the public schools, (2) the high schools, (3) the State universities.

III. In common with the newer States of the Union, Minnesota stands committed to the encouragement of higher education:

1. By having accepted from the general government three separate grants of public lands.
2. By having provided in the Constitution for a state university;
3. By a series of legislative acts and liberal appropriations;
4. By having authorized the establishment of municipal high schools, to be supported by taxation;
5. By virtue of custom and public sentiment. It will be impossible for Minnesota to depart from a policy which she has adopted in common with her neighbors, and to which the people are generally attached.

IV. The question then is, "How can Minnesota best encourage higher education?"

Answer.—By organizing and stimulating preparatory schools.

There is a wide gap between the extreme members of our system of public instruction, namely, the common school and the University.

This gap the high schools have not filled, and cannot, without beneficial legislation, fill. Why not?

1. Because, being city or village schools, supported by local taxes, they do not admit and cannot be expected to admit, students residing outside their districts, except on payment of tuition. The result is that there are *no free schools in the State to which a country boy or girl has a right to go to prepare for College;* and this in the face of the indisputable fact that it is from the country districts and the smaller villages that colleges are steadily recruited. Out of 237 students attending the University of Minnesota in 1874, 105 were sons and daughters of farmers.

2. Because the high schools, although in many cases teaching all the branches needed for entering college, *do not arrange their courses* in such a manner as to accommodate students desiring to fit for college. There are instances in which boards and principals take the ground that the high school is the crowning member of the system of public instruction, and thus actually discourage students from going to college or the university.

3. The high schools are few, and are confined to the cities and large villages. There are 100 villages in the State, which for lack of wealth and population cannot have high schools at all; such communities, if aided by the State, can support undenominational academies. This is the New York State plan; $47,861.98 were appropriated for the support of academies in the year 1874.

There ought to be within ten years one hundred free high schools and academies in the State, accessible directly from the *homes* of the people.

V. What is the consequence of the weak and undeveloped condition of Secondary education?

1. Take the ten States of the Mississippi Valley north of the Ohio River. Out of some 23,000 students attending the colleges, 37 per cent. *only are reported as college students;* 63 per cent. are *preparatory students,* i. e. students who ought to be in preparatory schools and not in colleges. Eighty-three per cent. of the college students in the colleges of the northwest have been prepared by the colleges themselves; about ten per cent. in city high schools, the remaining seven per cent by academies, or by private study. See report of Bureau of Education, 1873 and 1874.

2. Take the State universities of the same States, only one, that of Michigan, has dropped preparatory work; and this has been made possible by an arrangement with the high schools. The Supreme Court of Michigan has decided that it is lawful and constitutional for the high schools to open courses preparatory to the university. The beneficial influence upon the high schools themselves is testified to by witnesses of the highest character. As to the remaining State universities, forty-six per cent. only of their students are *reported as college students;* fifty-four per cent. are preparatories. In the University of Minnesota at the present time, sixty per cent. of the students are preparatory, and forty per cent. proper college students.

VI. The question then is: Will Minnesota perpetuate this costly and extravagant policy of having her University and Colleges prepare their own students, or will she so legislate as to relieve them of this burden, and at the same time carry the secondary education to the doors of the people who pay for it?

The State University has already dropped off one preparatory class, and arrangements have been made to discontinue another. Should this bill become a law, within a short time all preparatory work could be dropped, and a great amount of money saved.

So soon, therefore, as the legislature shall have made suitable and sufficient provision for preparatory instruction in the high the Board should at once determine and announce a time for dropping (1) the fourth class, and (2) the third class. The discontinuance of additional secondary instruction (as contemplated by our general plan of organization) could naturally and wisely be left for future consideration.

The project of holding examinations for admission in different quarters of the State, heretofore authorized by the Board and put into operation in a tentative way the past summer, promises to re-

sult beneficially. The expense of the University is small when compared with the saving to the numerous candidates. The institution is favorably and effectually advertised, and the performances of the candidates are doubtless much better than they would be under the usual circumstances and distractions. There are many conclusive reasons for continuing these examinations. Should the Board so resolve it is important that they be carefully planned and distributed; the number should be restricted as much as possible, and timely notice of all appointments should be extended throughout the several districts.

GRADUATIONS.

At the fifth annual commencement, held June 7, 1877, the following degrees were conferred :

COLLEGE OF SCIENCE, LITERATURE AND THE ARTS.

Bachelors in Arts.

Graham Cox Campbell	Nova Scotia.
Joel Nathaniel Childs	Prescott, Wis.
Ebenezer Currie	St. Charles.
Frank Eustis	Minneapolis.
Fred Eustis	Minneapolis.
Stephen Mahoney	Belle Plaine.
John Waldo Perkins	Monticello.
Charles Wilbur Savidge	Cleveland.
Albert McClure Welles	White Bear Lake.

Bachelors in Science.

Albert Preston Hendrickson	St. Paul.
John Charles Kassube	Minneapolis.
Edward Burnham Pribble	Osseo.

Bachelors in Literature.

Matilda Jane Campbell	Machias, Me.
Viola Fuller	Austin.
Charlotte Adelaide Rollit	Minneapolis.

COLLEGE OF MECHANIC ARTS.

Bachelor in Architecture.

Walter Stone Pardee	Minneapolis.

A brief address delivered on this occasion is hereto appended, and offered as part of this report.

The following table shows the number and kinds of degrees which have been conferred by the University Inasmuch as the degrees form the natural termination of the several undergraduate courses of study, and students are at perfect liberty to choose from the courses, the table may indicate the relative "popularity" of the courses.

	1873.	1874.	1875.	1876.	1877.	Total.
Bachelor of Arts	2	1	3	4	9	19
Bachelor of Science	......	1	2	5	3	11
Bachelor of Literature	......	......	1	......	3	4
Bachelor of Civil Eng	......	......	3	3	......	6
Bachelor of Mech. Eng	......	......	......	......	......	......
Bachelor of Architecture	......	......	......	......	1	1
Bachelor of Agriculture	......	......	......	......	......	......
	2	2	9	12	16	41

EQUIPMENT.

EXPERIMENTAL FARM.

The report of Assistant Professor Lacy, herewith transmitted, embraces detailed statements of all the operations carried on. While these statements are in themselves interesting and of some value, it ought to be borne in mind that their main worth rests in their relation to the series of which they form a part. In a climate so variable as that of Minnesota, and amid conditions so fluctuating, no one year's observations or experiments can furnish reliable precedents. It is a noticeable fact that one of the eastern agricultural colleges carrying on more extended and varied experiments than perhaps any other, refuses to make any discussion of any single year's observation. The resulting figures are merely published and left for future comparison. The plant house, also under the care of Mr. Lacy, has proved an excellent auxiliary to the horticultural and botanical instruction. As the improvised arrangements and equipment of this establishment give room to a permanent management its usefulness will become more marked and apparent. Credit must also be given to the department of agriculture for a considerable amount of labor in cleaning up the University grounds. The vigorous enforcement by the city authorities of the ordinance prohibiting the running at large of animals, has occasioned much appreciated relief from a chronic annoyance. The question is suggested whether the expense of building and maintaining a long line of boundary fences may not wholly be spared.

The partial extension of these grounds by the judicious liberality of the legislature is a cause of sincere congratulation.

GENERAL MUSEUM.

The collections have been increased by the accessions from the geological survey and by limited purchases, as will be shown by the report of the curator, appended to the report of the geological survey. Meagre as is the display of objects in this establishment, it renders excellent assistance to instruction in more than one department and attracts and gratifies numerous visitors. I would respectfully ask attention to remarks in the last report touching the value of the museum and the means indispensable to its growth.

The special collections for illustration in the department of ancient languages, history, chemistry, and agriculture have been augmented by additions of much usefulness at inconsiderable expense to the Board. The acknowledgments of the Board are due for the following donations, made through Professor Peckham, to the

MUSEUM OF TECHNOLOGY.

11 specimeus of coal, 4 specimens of pig iron, Kanawha Valley, W. Va. Presented by J. D. Budd, Esq., Richmond, Va.

12 specimens of blast furnace slags, iron ores and coal, from the Bellefont Nail Co., Ironton, O.

3 specimens of iron ores and puddling furnace slags from the Covington Rolling mill, Covington, Ky.

8 specimens of cullet and proofs of flint glass from Hemmingray's Glass Works, Covington, Ky.

2 specimens of English and French plate glass from Messrs. Beck & Rank, St. Paul.

24 specimens illustrating the manufacture of American Plate Glass, from the Star Glass Works, New Albany, Ind.

1 large specimen of silver ore, amalgam and core from Diamond Drill, from A. C. Rand Esq., Minneapolis.

1 large specimen micaceous iron ore, from J. A. Armstrong, Minneapolis.

1 large specimen Navassa phosphatic guano, from John Ott, Esq., Richmond, Virginia.

2 specimens of Minnesota and Dakota coal, from Hon. Wm. R. Marshall, Saint Paul.

4 specimens coal and coke from Gen. St. John, Richmond, Va.

19 specimens Virginia iron ore from R. Peckham, Esq., Richmond, Va.

1 specimen argentiferous galena, from Montana. T. M. Blossom, Esq.

28 specimens Rhode Island coals, ores and slags, from S. F. Peckham.

1 specimen of kaolin, from Greenwood Pottery Co., Trenton, N. J.

18 specimens drystals and ores from gold mines near Georgetown, Col., from S. A. Rank, Esq.

100 lbs. magnetic iron ore, Port Henry Iron Ore Co., Port Henry, N. Y.

100 lbs. magnetic iron ore, Arnold Mine, Ferona, N. Y.

1 glass pot, Whitall, Tatum & Co., New York city.

1 bottle mould, Whitall, Tatum & Co., New York City.

26, specimens illustrating the manufacture of bottle glass. Whitall Tatum & Co., New York City.

15 specimens East India gums and spices from J. W. Rulon & Sons, Philadelphia, Pa.

18 specimens of varnishes and gums used in their manufacture, from Chas. C. Phillips, Philadelphia, Pa.

1 specimen mineral wool, from R. D. A. Parrott, Greenwood furnace, Orange Co., N. Y.

A large collection of cotton warps and yarns, prints in process of manufacture, materials used in printing, dye woods, etc., collected by S. F. Peckham, and contributed for the most part by the Georgiaville Manufacturing Co., Allen's Paint works and Richmond Manufacturing Co. of Providence, R. I., through their superintendents.

3 specimens of blocks used in hand printing about 1835, from Richmond Manufacturing Co., Providence, R. I.

Specimens of pottery and materials used in its manufacture, from Mercer Pottery Co., Trenton, N. J.

1 specimen of rock salt from Louisiana. Hon. Richard Chute. Minneapolis.

Specimens of Cryolite and products manufactured from it, from Pennsylvania Salt Co., Natrona, Pa.

9 specimens of Stassfurth Salts from Stassfurth, Prussia, obtained through Herr Ernst Althans, Inspector of mines for Silisia, Besla, Silisia.

A collection of furnace products and ores with a diagram illustrating the metallurgical process employed at Freidrichutte near Tarnowitz, in Silisia; also obtained through Herr Althans. An exceedingly valuable collection.

A collection of more than 200 specimens of raw drugs, fixed and essential oils, glues, etc., from Messrs. Noyes, Bros. & Cutler, St. Paul.

A collection of ores and pig irons from Tennessee, Colorado and Lake Superior. Presented by Byron M. Smith, Esq., of Minneapolis.

A valuable collection of gold and silver ores from Colorado. Presented by E. S. Alling, of Ouray, Colorado.

Parties having ores or other technological products which they wish to donate to the Museum of Technology, will please address Prof. S. F. Peckham.

LIBRARY.

The number of bound volumes added to the library during the year was 900, of which 51 were donations from various individuals and officers; 461 were purchases; the remainder, 378 were received from the State Library.

Appendix B is a complete list of all these accessions.

The following donations have been duly acknowledged on behalf of the Board of Regents.

LIST OF DONATIONS

To the Library of the University of Minnesota during the University year, 1876–7.

Rev. Theo. M. Riley, Minneapolis:
Some Elements of Religion.

Seneca G. Lapham:
Biography of Increase A. Lapham.

Prof. R. W. Laing, LL. D., Minneapolis:
Venable; History of the United States.
Bryce; Second Greek Book.
Norton; Elements of Scientific Agriculture.
Johnson; Elements of Agriculture, Chemistry and Geology.
Hooker; Natural Philosophy.
Loomis; Elements of Natural Philosophy.
Cooke; Cavalry Tactics.

Rev. C. E. Thayer, Minneapolis:
Horae Solitarie.
Knowles; Memoir of Mrs. Judson.
Clement; Memoir of Adoniram Judson.
Shirlock; Scripture Truths of the Divinity of Christ.
Virgil; Opera.

Discourses delivered in Murray Street Church.
Allen; India, Ancient and Modern.
Brace; Hungary in 1851.
Smith; History of Wisconsin.
Report of Wisconsin State Historical Society for 1856.
Quarterly Observer.
Report of Minnesota Historical Society for 1856.
Agricultural Reports for 1865–66.
Brown, Thos.; Lectures on Philosophy.

Hon. Paris Gibson, Minneapolis:
Labor in Europe and America.

C. **Evans**, Librarian, Indianapolis:
Catalogue of Public Library of Indianapolis, 1873.

G. C. Campbell, University of Minnesota:
Dr. Alexander Forrester's Teachers' Text Book.

Robt. C. Winthrop:
Biography of Washington, Bowdoin and Franklin.

Hon. A. R. McGill:
Annual Report of the Insurance Department of New York.

W. H. Smith:
The Tailed Amphibians.

Col. W. C. Patterson:
Campaign of 1861.

W. E. Leonard, B. A., Minneapolis:
Elements of Agricultural Chemistry.

Prof. Ezra C. Seaman, Ann Arbor:
Views of Nature.
A Summary of a Paper "On Life."

Hon. John H. Stevens, Minneapolis:
Hedges and Evergreens.

Prof. S. F. Peckham, University of Minnesota:
Elementary Chemistry.

Rev. David R. Breed, D. D., St. Paul:
History of House of Hope Church.

U. S. Government, through Departments:
Hayden; Annual Report of the U. S. Geological Survey.
Report of Supervising Architects of Treasury Department.
Report of Commissioner of Indian Affairs.
Raymond; Statistics of Mines and Mining.
Finance Report, 1875.
Condition of Affairs in Alaska, 1874.
Report of the Chief of Engineers, 1875.
Exploring Expedition from Santa Fe to Green river, Geology.
Explorations Across Utah in 1859.
Report of U. S. Commission of Vienna Exposition, 1873.
Report of the U. S. Coast Survey, 1873.
Sketch of the U. S. Naval Academy.
Dodge; Centennial Album of Agricultural Statistics.

Hon. W. R. Marshall, Ex-Gov., St. Paul:
Report of Railroad Commissioner of Illinois for 1875.
Report of Railroad Commissioner of Wisconsin for 1874.
Report of Board of Railroad Commissioners for 1875.

Dominion of Canada:
Geological Survey, Reports of Progress, 1874-5.

U. S. Government:
Complete set of Executive, House and Senate Documents for 1 Session of 44th Congress, 1875-6.

By authority of the last legislature the State Library was authorized and directed to turn over to the University its miscellaneous books and pamphlets. The whole number of bound volumes received was 1473; pamphlets 156; total 1,629 Ninety-eight bound volumes of special value in completing the collections of the Minnesota Historical Society were left in custody of their librarian, Hon. J. F. Williams. There remained 1,375 bound volumes. After setting aside the State and United States documents, duplicates, broken sets and damaged volumes there remained but 378 works to be added to the library. It is unfortunate that a once large and valuable collection of books should have been so decimated and plundered.

LIBRARIAN'S FUND.

The Librarian herewith presents, as required by resolution of the Board, a full account of the purchases made out of the fund of $250 placed at his disposal. The whole number of volumes purchased is 226. The sum expended is $207.72. The balance remaining on hand is $42.28. It is believed that an inspection of these books will satisfy the Board that the funds have been used judiciously.

READING ROOM.

The following is a list of periodicals supplied to the Reading room, those marked with a star having been furnished gratuitously by the publishers.

Quarterlies.—Journal of Speculative Philosophy, Edinburgh Review, Westminster Review, London Review, North British Review, Mind.

Bi-Monthly.—North American Review, International Review.

Monthly.—Blackwood's Magazine, Scribner's Magazine, Harper's Magazine, Eclectic Magazine, American Journal of Science, Atlantic Monthly, Popular Science Monthly, Van Nostrand's Engineering Magazine, Appleton's Art Journal, Contemporary Review.

Semi-Monthly.—American Bookseller.

Weekly.—Library Journal, Littell's Living Age, The Nation, Scientific American, Harper's Weekly, Nature (Eng.,) Uber Land und Meer (Ger.,) Patent Office Gazette,* Hutchinson Enterprise,* Glencoe Register,* Anoka Sun and Republican,* Minneapolis Freie Presse* (Ger.,) Minnesota Staats Tidning* (Swede.)

Semi-Weekly.—New York Evening Post.*

Daily.—War Department Weather Map,* St. Paul and Minneapolis Pioneer-Press,* Minneapolis Tribune.*

It is highly desirable that the appropriation for the purchase of periodicals be increased, the present sum barely sufficing for the purchase of a few representative magazines and reviews devoted to general literature and science. The more costly periodicals devoted to specialties, such as chemistry, philology, etc., indispensible to professors ambitious to keep abreast of the advance of their several departments, cannot be afforded. All such matter it must be remembered, is of permanent value when bound and shelved in the library.

The librarian respectfully calls attention to the importance of a printed catalogue of subjects, a matter discussed in full in the last report. I would respectfully ask serious consideration of this matter at the annual meeting.

The following appropriations are respectfully recommended: for the purchase of books $1000; $750 to be expended under the direction of the general faculty, $250 by the librarian as heretofore; for the purchase of periodicals $200.

STATISTICS.

The library and reading-room were open seven to nine hours daily, except Sundays and legal holidays, from Sept. 26, 1876, to June 1, 1877, in all 206 days, During vacation the library was open two hours per week for the issue and return of books loaned.

The number of books loaned to students was 2,356; to faculty, 669. The number used in the reading-room by students was 3,200; by professors, no count, but a very large number. The whole number of bound volumes, exclusive of public documents, state and national is 9,217.

According to an actual count there are the following numbers of *works* pertaining to the several departments named:

Mathematics	105
Astronomy	54
Chemistry	61
Physics	74
Geology, &c	58
Botany	26
Zoology	50
Physical Geography	127
English	797
Northern European Languages	190
Southern European Languages	183
Greek	222
Latin	223
Comparative Philology	165
Metaphysics	310
History	399
Voyages and Travels	728
Biographies	450
Social Science	313
Elocution	21
Public Health, Medicine, &c	71
Industrial Drawing	20
Fine Arts	71
Agriculture	142
Civil and Mechanical Engineering	158
Military Science	76
Education	130
Business	16
[Divinity]	458
[Biblography]	51
	5,749

The loss of 16 volumes (temporarily, it is believed) has led to a strict enforcement of this rule of the Board, that "No person shall, *under any* pretense, remove a book from the library until it has been regularly charged and delivered by the librarian."

The following table shows the use made of the library by students and professors for the last five consecutive years.

Year ending in June.	'73	'74	'75	'76	'77
Biographies	121	83	134	147	170
Histories	94	139	219	300	489
Novels	163	96	176	446	513
Belles Letters, Prose	117	101	161	186	267
" " Poetry	140	107	167	143	156
Ancient Language and Literature	12	41	41	68	54
Modern " "	53	92	104	64	120
Natural Science and History	83	106	107	121	93
Mathematics	95	43	28	31	18
Travels	108	99	145	111	105
Political Science	32	23	55	45	84
Miscellaneous	191	103	165	169	144
	1,360	1,066	1,569	1,904	2,356
Loaned to Faculty	203	166	471	486	669
Used by Students in Reading-R.	370	500	720	1,650	3,200
	1,933	1,622	2,750	4,040	6,225

APPARATUS.

The accession of several pieces of electrical apparatus and a celestial globe, is all that is to be noted. There is hardly a single department which is not hindered and crippled for lack of sufficient means of illustration, the department of astronomy conspicuously so.

BUILDINGS.

The buildings continue in good condition and with the exception to be noted are sufficient for the accommodation of the departments now organized. Should the means of rapid development be placed within reach of the Board, it would at once become important to plan for the accommodation of increased numbers of students and new departments of instruction. The library cannot be confined to its present quarters for many years ; the museum will soon outgrow the space allowed. The museum could be easily accommodated for many years if the space now devoted to the large assembly hall could be vacated. Provision should soon be made for the literary societies, on a permanent and liberal scale.

The immediate and pressing demand, however, is for a drill hall for the military exercises. I would respectfully request that this matter receive immediate and serious attention. The

MILITARY DEPARTMENT

ought in my opinion to be suitably equipped or promptly abolished. In accepting the grant of public lands of 1862, the State assumed all the obligations incident to the trust. Among other branches to be taught in these national colleges, Military Tactics is expressly "*included.*" A variety of questions present themselves at this point to confuse the discussion, as for example:

1. Shall military exercises be required of all the students?
2. Shall they merely be *offered* to such as may fancy them, the same as ancient and modern languages, higher mathematics, analytical chemistry, etc., are offered?
3. What shall be the extent of the military instruction?
4. Shall students be required to wear a uniform dress?

All these are after considerations; the first consideration is that the Military Department be located and equipped in such a manner as to enable it to do *anything* worth naming.

Subtracting the long winter of our latitude from a scholastic year, beginning in September and ending in June, there remains but a very small space in which out-door manœuvres are possible. A drill hall is therefore simply essential to extended and thorough work.

In regard to the past the Board have fully discharged their duty by providing for such exercises and instruction as has been possible with the means and facilities under their control. Although the results have been meagre compared with those which might be expected under more favorable circumstances, still in the aggregate a good deal has been accomplished through the efficiency of the officers of the army stationed here by the War Department. The Board may therefore confidently refer the matter to the Legislature, either to provide the necessary equipment or assume all responsibility for diminished results.

Before leaving the topic I desire to record my opinion, formed after deliberate reflection upon our experience, that the Department of Military Science and Tactics should be liberally supported and encouraged in the national colleges. The present indications are that the time when civilized nations will learn war no more is very far away. It is therefore a wise policy, and one that should be strenuously insisted upon, that the young men who are trained under the national endowment should be so instructed that in case of need they may be competent to act in the nation's defense. I can think of no manner in which the nation can secure the diffusion of military skill and science so widely and efficiently as through these institutions. The number of officers available for giving the instruction ought probably to be greatly increased, not only for the purpose named, but for the reflex influence upon the army itself, through the experience thus acquired by the younger and more scholarly officers detailed as instructors.

There is still much to be done in the way of harmonizing the military work with the ordinary scholastic instruction. In some institutions the garrison discipline can be introduced with great advantage. Others, especially those having no dormitories and instructing both sexes cannot use this routine, but in these

the military exercises, both theoretical and practical, may have their appropriate times and places. The practical question of most immediate importance, in my opinion, is how to grade and classify these exercises, so as to present them in proper succession to the various classes of a school or college, and thus avoid the disgusting monotony of mere "drill." Professor Lundeen has, I believe, already made some excellent arrangements in this regard, and, I am happy to record, has made preparations hereafter to teach his students not merely how to hold and "carry" arms, but how to *shoot* with them.

I will only add that the military exercises, as a gymnastic, and as a means of cultivating orderly and gentlemanly demeanor, commend themselves at once to all.

MISCELLANEOUS.

GEOLOGICAL SURVEY.

A memorandum kindly furnished by the State Geologist, Professor N. H. Winchell, in advance of his annual report, enumerates the following contents:

"The Geological Report will consist of detailed reports on four counties (Ramsey, Rice, Rock and Pipestone); a discussion of the water supply in the Red River Valley; reports of Reconnoisances in Wright county; on a hunt for "coal" in Rice county, in Goodhue county and in Morrison county; and along the Northern Pacific and St. Paul & Duluth Railroads; further contribution to the Palaeontology of the Trenton; Report of Prof. Peckham giving analyses of water from Red River Valley, and of samples of limestone from Minneapolis, etc., etc.; Dr. P. L. Hatch's report on Ornithology; and Mr. A. Whitman's on the last year and disappearance of the grasshoppers. There will also be a report on operations in the Museum for the year, giving a list of identified fossils from the Trenton, and a list of minerals added to the Museum."

The recommendations made in the last report are respectfully repeated.

It seems to me of the highest importance that the operations of the survey, heretofore confined to the more accessible part of the State, should at once be extended to those quarters reported to abound in valuable mineral. No work of permanent value, however, can be done in those parts without much more money than has yet been at the disposal of the Board. This subject is most earnestly recommended for immediate consideration. It is probable that the earlier reports of the Survey will have to be reprinted so great is the demand for them by learned societies and citizens.

PROPERTY RETURNS.

Under the instruction of the executive committee a set of blanks have been prepared and printed for obtaining and continuing a complete and systematic account of the miscellaneous property of the University. The following are the headings of these blanks:

Return of Public Property appertaining to the [Chem. Lab., &
of the University of Minnesota, in custody of Prof.
for the ending 187

THE UNIVERSITY OF MINNESOTA—RETURN OF PUBLIC PROPERT

Class.	ITEMS	On hand at last Report.		Received since last Report.		Total to be Accounted for		Disposed of since last Report.		Remaining	
		No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.	No.	

In connection with this topic I deem it my duty to suggest t considerable improvements could be made by the Board in the m ner of conducting its accounts. In particular the number of p sons making expenses should be as small as possible, and saving emergencies no expenses should be made except by vote of Board or an authorized committee *in advance*; and further w outlays so authorized have been made there should be a single definite channel through which the vouchers should reach the tr ury.

WANTS.

It is proposed at this time merely to summarize the needs of institution, many of which have been more fully stated and gued in previous reports.

1. A drill hall and gymnasium. Probable cost $5,000.

2. An astronomical observatory. The sum of $10,000 would sufficient to procure and shelter an outfit of working instrume of moderate capacity.

3. A large supply of new books for the library. $5,000 upwards.

4. Apparatus and means of instruction in nearly all departmen $3,000 and upwards. The department of mechanical engineer needs a complete outfit to enable it to do its appropriate work. T Agricultural and Mechanical College of Virginia expended last y in this department the sum* of $3,733.07.

5. An independent professorship of Physics. This departmen so extensive and so rapidly growing that it cannot consistently profitably remain attached to the chair of Chemistry.

6. An independent professorship of Rhetoric. This item fully discussed in the last report.

7. A professorship of Botany and Zoology; also referred to in last report.

*For engines, planers, lathes, saws and other machines	$3,23
For carpenter's tools	17
For blacksmith's tools	12
For miscellaneous tools	19
	$3,73

8. A paid board of examiners. Following the custom of our country we are conferring degrees upon the strength of examinations held by the individual teachers in the several departments of instruction. It needs but a moment's reflection to perceive that such an arrangement as this is essentially absurd. The time must come when American universities will adopt the better custom of those of older and wealthier countries, and separate the teaching and examining functions.

9. New departments, especially that of law, to be opened so soon as the state of the finances will warrant.

10. A ladies' Hall or Home, preferably to be provided by private liberality.

THE FUTURE.

Since the close of the year covered by this report* the University has entered upon the eleventh year of her practical existence. She has taken her place among the colleges and universities of the northwest, challenging competition and patronage. Considering the newness of the State, the long-continued financial depression of the country, and the repeated visitations of the locust plague within our borders, it must be acknowledged that Minnesota has dealt liberally with the University she has founded, and I trust that the results of the last nine years work will show themselves in the future prosperity and renown of the State. Not far from fifteen hundred young people have been under your care and instruction. But for the existence of this institution and the free gift of its advantages, the great majority of these youth must have been content with the bare rudiments of learning. It is a noble thing for this young commonwealth that it has for so many years kept open the doors of its highest school to the children of the humblest and poorest citizen. That this generous policy has been most gratefully appreciated I am able to testify. The condition of the institution is on the whole gratifying, a goodly number of professorships are ably filled, the buildings are well adapted to the work now carried on, the means and facilities of instruction are creditable to an institution of so short a history, the number of students has increased in a rapid but steady proportion, the higher classes are constantly growing in numbers and culture, while the qualifications of candidates for admission are rising and broadening.

With the present income and equipment the University can continue to exist and to carry on the work she is now doing.

But the question instantly arises, Shall the University of a state advancing in population, wealth and culture, remain in a stationary condition, or shall she keep pace in her appointments with the general progress? Should anyone desire it the stationary condition is not in these times possible. A state university is not exempt from the rule of the market. If the advantages she offers are inferior, students of enterprise will abandon or avoid her. If the state cannot and does not in her public University afford ampler

*The first scholastic work of the University began Oct. 7, 1867.

and better instruction than private means can, then the state should quit the field. The State University *must* be stronger and greater and more beneficent than any other college or be ridiculous. If this University, therefore, is to live and to maintain a reputable competition with others of its name and rank, its revenues must be immediately and largely augmented.

What Burke said of the state, "The revenue *is* the state," might with equal truth almost be said of a university. In what manner to increase the annual income, whether by the sale of lands, by state appropriations, by increase of fees, or by all is a question for the Board which I have no occasion to anticipate. The University needs an income of $50,000 a year for the remainder of the decade, and the sure prospect of a large and steady increase thereafter, if the people desire and are resolved to have a university worthy the title. A comparison of the work and the incomes of other institutions will render this apparent. As a single instance, reference may be made to our next neighbor, Wisconsin. The university of that state has one more department—that of Law—and a few more students than this institution. The present annual income fixed after severe legislative scrutiny, is, in round numbers, $80,000. Large additional appropriations have been made for buildings, furniture and apparatus. The circumstance of the location of that university at the state capital, in close proximity to the great libraries of the state and the historical society, relieves the university of the enormous cost of collecting and preserving a large library. Happily our state has refrained from the establishment of duplicate libraries, so that doubtless corresponding provision will be made for the library which must here be collected.

If the University then is to compete honorably with her neighbors, if the state through her will afford to her youth educational advantages adequate to the demands of the times and her own honest pride, her income must be at once increased and assured for the future.

The liberal dealing of the past is an earnest that the just and reasonable demands and representations of this Board will be honored by the representatives of the people. It is my conviction that this Board have at all times been over modest and scrupulous in their requisitions on the public resources. In view of the great and precious trust held by you for the present and the coming generations of scholars in our State, I believe you may with confidence appeal to the people for that generous and permanent revenue, by which alone your great work can be successfully prosecuted.

All of which is respectfully submitted.

Short Address by President Folwell, upon conferring the Degrees at the 5th Annual Commencement, June 7, 1877.

Mr. President :—At this hour I waive my privilege of extended speech and only ask leave to say one word about these candidates, and one other word to them.

I could justly commend them to you and praise them as having been diligent in study, punctual and faithful in duty, modest and virtuous in life and conversation, and in many other ways. but I will only mention them to you now as conspicuous for loyalty and pride in their Alma Mater, and as having exerted a strong and steady influence for good during their residence here. In saying this I am sure I detract nothing from the high merit of former classes, and I wish my emphasis to lie upon the circumstance that it is this class as a body whose influence has been so marked and salutary.

Several things have conspired to occasion this. The class has been happily composed of persons who came here with definite aims and resolutions with regard to their education and the use to which they would put it. The majority of them had had or have had successful experience as teachers and were able from the outset to appreciate the relations of all composing the academic community. Something also is due to the circumstance of numbers. Compared with all our former classes this class is a numerous one, and I mention with great regret that since the opening of the spring term, one member, Mr. Harvey Jay Smith, disabled by severe illness, has been forced to drop from the ranks. Happily we have reason to hope for the restoration of his health and his graduation at no distant day.

But irrespective of numbers or other circumstances the individuals composing this body of candidates would at any time have distinguished themselves as I have mentioned. I speak what is well known and acknowledged here, that this class have at all times stood solid and firm for the right and have set a constant and conspicuous example of orderly and sober conduct.

I take pleasure in giving this testimony in a public manner in the presence and hearing of the remaining body of undergraduates, and I will use the occasion to remind them of the great responsibility which rests upon them in maintaining the good name and fame of the University.

There have been great changes in college administration within the past generation. The abolition or amelioration of the dormitory and tutorial system have extended to college students a larger freedom than is perhaps enjoyed by any other class of persons. Although held to strict account for attendance upon the appointed recitations and exercises, and stringently required to perform certain duties they are necessarily for the greater part of their time masters of themselves. At the close of each daily college session, the student body dissolves into the general mass of resident citizens. There is and can be no tutorial visitation nor surveillance. With the obliteration of the old quasi-monastic usages, there has come a corresponding change and betterment in the relations of the members of the University. The broad chasm which once separated lay students from ecclesiastical professors has perceptibly narrowed, and both now stand on common ground as joint seekers after truth and knowledge, and a happy day will it be when the last vestige of that patronizing distrust and grim surliness, which of old marked the intercourse of collegians and their masters, shall be wiped out.

But then, it must be remembered the responsibility for order and progress will no longer rest so much upon college instructors, but all the more upon college students, and upon them must fall no small share of the odium justly attaching to inferior scholarship and disorderly behavior.

More especially will this responsibility fall upon the experienced students of the upper classes who of necessity give the tone and color to the whole contemporary life of the institution.

Dr. Arnold of Rugby, once said to the members of his highest class, "If the sixth form do not support me I must resign this work."

Many a college faculty have felt their hands stayed up by the moral support of a senior class of strong, brave young christian men, or men and women.

I believe the example of the class now about to leave your care will endure, and will have set a wise and benificent fashion in this University, which will be useful and precious to their successors.

And now one word to the candidates. We part with you to-day not merely as from pupils, but as from fellow laborers and co-partners in a noble work. We remain to carry forward this work. You pass to other duties amid other scenes. You are full of hope and courage, resolved to strike sure and strong for the right. For one I would not too readily disturb your dreams of a smooth and stormless voyage to that haven of prosperity where you would be. No, cherish your ideals, cultivate hope and cheerfulness, resolve to extort comfort out of disaster. "Rejoice O young man in thy youth, and let thy heart cheer thee in the days of thy youth." * * these as well as the words which next follow them, and which have often been read in your hearing, are the words of wisdom and inspiration.

Therefore I say be strong, be hopeful, but also be modest. Remember "there is a hand that guides," and which will often best use your plans by utterly thwarting them. Go then as to a post of

duty, remembering that duty dignifies and sanctifies the lowliest toil and that faithfulness in a few things is your surest title to the royal crown.

I have seen somewhere this heraldic device, which I commend to your reflection. On the one hand an altar, on the other a plow, and a motto "Ready for either."

PROFESSOR LACY'S REPORT.

Wm. W. Folwell, President of the University of Minnesota :

SIR :—I respectfully beg leave to submit the following report of the College of Agriculture, for the year ending Oct. 31, 1877.

INSTRUCTION.

Two students have received direct instruction in agriculture during the past year. One pursued the subject of "How Crops Grow," "How Crops Feed" and "Farm Drainage," during the 2d and 3d terms. 1876–7. And one student at the beginning of the present school year began the subject of "How Crops Grow," but has since withdrawn from the University.

Another year's observation has only confirmed what was written in last report concerning the demand for direct instruction in agriculture. Meanwhile some efforts have been put forth to measure and encourage this demand. In the month of July, 1877, 500 small posters were sent to as many different post-masters, railway agents and newspapers in this State, with the request to post in a conspicuous place. These mentioned with special prominence "two special courses for the years 1877–8, open to all without preliminary examination." How many of these posters ever reached the walls for which they were intended is, of course, unknown. This much only is known—They evoked not one single answer or inquiry.

NOTE.—Later, 500 postal cards, asking for the names and addresses of any young men who might wish to pursue studies in agriculture were sent to farmers of American birth and to editors of newspapers at over 300 different postoffices. To these a few direct answers have been received. To the addresses received circulars of information have been sent together with a postal card, calling particular attention to the special courses above mentioned and stating that if desired special classes would be formed in horticulture, arboriculture, practical agriculture, farm drainage, farm accounts or other similar subjects ; and in case classes were not formed in these subjects, persons could pursue them on their own account and receive all the assistance which the apparatus and teachers of the institution could afford.

This will result in the spread of information relating to the Agricultural College, if nothing more, which, according to the Hon. L. B. Hodges, is much needed. He says: "It is a lamentable fact that thousands of farmers and farmers' sons in Minnesota do not know that there is an agricultural department to the State University—men too who would make great effort to give their sons the advantages you offer, were they only aware of what is taken for granted that every one knows." Some of the cards sent to editors were printed and have led to a few inquiries. With the permission of your Board, this method of advertising will be continued in the future.

LIBRARY.

Several important and valuable works on agricultural subjects have been added. The "Farmers' Union," "Prairie Farmer," "Scientific Farmer," "Gardener's Monthly and Horticulturist," and "American Agriculturist," have been regularly received in the Reading Room.

MUSEUM.

A case has been constructed in the room to be occupied by the Museums of Agriculture and Technology in the Agricultural building, and the objects thus far stored in a basement room in the main building, will shortly be removed to this case. The College of Agriculture now possesses what is undoubtedly the best collection of grasses, cereals and seeds, to be found in this State; numerous additions having been made from the Experimental Farm, the past season.

ORCHARD AND FRUIT GARDEN.

Nothing needing mention has here occurred or been done.

NURSERY.

The Larches heretofore growing south of University Avenue near the barn, were transplanted to the sandy knoll north of the Avenue, with a loss of all except about 75 out of 920. The loss was undoubtedly due *both* to the conditions of growth and to faulty method in transplanting. They grew on sandy soil, and when dug, the roots were found to be short and the rootlets few. They were replanted in soil of the same kind, where the nourishment supplied by a limited quantity could not be large. The trees were dug as soon as the frost liberated their roots, and placed in a cold cellar, but even here the buds burst and the leaves started before they were set in the nursery. More than half the branches were cut away. More could not be taken without serious injury to the forms of the trees. But the roots could not obtain sufficient nourishment and moisture to continue the growth already started, and the trees per-

ished. Elms that were dug at the same time, and heeled in until the leaves had opened, then set in a very sandy soil, continued to grow until midsummer, when the drouth caused the leaves to dry and fall. Later, when the rains came, these trees revived and leafed out again.

VEGETABLE GARDEN.

Experiments with different varieties of garden vegetables have been continued on the same plan, in about the same number, and with the same objects in view as in 1876. The more important results are detailed in the following pages.

DWARF BEANS.

Varieties planted.—Early Six Weeks, Black Wax, White Wax, Early Mohawk, Golden Wax, Early China, Early Valentine, Early Refugee, Newington Wonder. (Busch, Hollists and Carter.)

Concord Bush, Early Fegee, Dun Cranberry, Yellow Eye, White Pea, (Gregory.) Early Round Yellow Six Weeks, (Bliss & Sons.) Early Rachel, (State Experimental Farm.)

The Black Wax, White Wax and Golden Wax far surpassed all others in table quality. These three were about equal in this respect, equal also in earliness and as early as any other variety tried. In other respects they were different. The Black Wax had a long season, but the pods, though numerous, were small and short. The season of the Golden Wax was shorter but the pods much larger and more numerous than those of Black or White Wax.

The Early Rachel was equally early and much more prolific, but wanting in length of season and table quality.

Early Refugee was latest of all and very prolific, being at least two weeks later than those above mentioned.

NOTE.—The names in parentheses are those of the growers of the seeds or of the parties from whom the seeds were procured.

POLE BEANS.

Varieties planted.—London Horticultural, Concord, Boston Market, Pole Cranberry, Rhode Island Butter, Giant Wax, Marblehead Champion, Painted Lady, White Pole Cranberry, Yard Long, Mottled Cranberry, Australian Runner, Lamberson's White, Kentucky Wonder, (Gregory). Case Knife, Sieva, Lima, Scarlet Runner, (Busch, Hollister & Carter.) Dreer's Improved Lima, Indian Chief, (Bliss & Sons.) Southern Prolific, (U. S. Department of Agriculture.)

The difference in season and productiveness between Lima and Dreer's Improved Lima was not very marked. Such difference as there was, however, was in favor of Dreer's Improved Lima.

The Southern Prolific was indeed very prolific in blossoms and finally in pods, but these set so late that only the exceptionally late

season permitted us to see that the pods were very long and very tender, turning yellow when fit for use. A snap bean. The vine was very vigorous.

CAULIFLOWER.

Varieties Planted—Earliest Dwarf Erfurt, Early Paris, Carter's Dwarf, Veitch's Autumn Giant (Busch, Hollister and Carter.) Italian Early Giant (Gregory.)

Planted on soil which proved to be very ill-suited. The season was equally unfavorable. Under these circumstances, Earliest Dwarf Erfurt was the only variety that formed heads, and these were few and poor.

EARLY CABBAGES.

Varieties Planted—Little Pixie, Early York, Early Jersey Wakefield, Early Winnigstadt, Early Drumhead (Busch, Hollister and Carter,) Wheeler's Imperial, Early Blood Red (James Vick), Sugar Loaf, Early Ulm Savoy (Gregory.)

Above remarks concerning soil and season apply equally to these cabbages. Of the early ones, Early Jersey Wakefield and Early Winningstadt gave the largest number of fair sized heads. Early Ulm Savoy gave a fair number of small but solid heads. Of the Early Blood Red, but few plants were lost from any cause, and nearly every one produced a head small, but solid.

LATE CABBAGES.

Varieties Planted—Premium Flat Dutch, Fottler's Improved Brunswick, Filderkraut, Large Late Drumhead, Marblehead Mammoth (Busch, Hollister and Carter) Bacalan Late, Large Late Flat Dutch. (U. S. Dept. Agr.)

The same remarks apply concerning season and soil. The heading qualities may be stated as follows:

Premium Flat Dutch, 13 plants produced one head.
Fottler's Improved Brunswick, 52 plants produced one head.
Filderkraut, 29 plants produced one head.
Large Late Drumhead, 4 plants produced one head.
Marblehead Mammoth, 8 plants produced onehead.
Baccalan Late, 26 plants produced one head.
Large Late Flat Dutch, 6 plants produced one head.

SWEET CORN.

The following notes may be of some value:

Early Narragansett. Planted May 16; fit for use August 8; ears of medium size but very short.

Early Minnesota. Planted May 16; fit for use August 8; ears small and short.

Very Early Dwarf. Planted May 16; fit for use August 13; ears small and short.

Early Selected Sweet. Planted May 16; fit for use August 10; ears large but very short.

Crosby's Early. Planted May 17; fit for use August 11; ears large but short.

Moore's Early Concord. Planted May 16; fit for use August 18; ears large but short.

Scott's No. 1. Planted May 17; fit for use August 14; ears large and long.

Marblehead Mammoth. Planted May 17; fit for use August 20; ears very large and very long.

Russell's Prolific. Planted May 17; fit for use August 10; ears small and very short.

Extra Early Maine. Planted May 17; fit for use August 9; ears small and short.

Pratt's Early. Planted May 17; fit for use August 3; ears small and short.

CARROTS.

Varieties planted.—Early Horn, (Busch, Hollister & Carter.) Danver's, Improved Long Orange, Long Orange, Large Altringham, (Gregory.) James' Intermediate, Half Long Carentan, (U. S. Dept. Agr.)

Soil, sandy loam with nearly pure sand at a depth of eight to ten inches. The yield per acre in bushels of 60 lbs. each, was as follows:

Early Horn	124.7 bushels.
Danvers	146 bushels.
Improved Long Orange	50.9 bushels.
Long Orange	52.2 bushels.
Large Altringham	90.6 bushels.
James' Intermediate	55.5 bushels.
Half Long Carentam	35.9 bushels.

The superior yield of Danver's and Early Horn is partly accounted for by the fact that they are varieties with short, thick roots.

PARSNEPS.

Varieties planted. — Hollow Crowned, Student, Long Sugar, (Busch, Hollister & Carter.) Round Early or Turnip, Maltese, (Gregory.) LaVaque's, Fine Sugar, (U. S. Dept. Agr.)

Soil same as for carrots above. A violent wind coming soon after the plants appeared, carried away the soil from around the stems and twisted the latter so badly that but few plants survived. Of these the Round Early or Turnip gave about the best roots, while the Maltese did nearly as well. The remainder were quite inferior to these.

WINTER SQUASHES.

Varieties planted.—Cocoanut, Vegetable Marrow, (Gregory.) Winter Crookneck, Hubbard, Marblehead, Butman, American Turban, Boston Marrow, (Busch, Hollister & Carter.)

The Cocoanut was very small and of inferior table quality. Vegetable Marrow was very inferior in quality. Hubbard, Marblehead and Butman may be compared together. All were severely set back by the drouth. The Hubbard produced the largest size and greatest number of ripe squashes. The Butman stood next in size and number of ripe squashes produced and had more green ones remaining than either of the others. The Marblehead produced the fewest ripe squashes, and those of smaller size.

GARDEN PEAS.

Name of Variety.	Planting to first Picking	Yield.	Table Quality.	Picking Season.	Size of Vine.
	Days.				
Early Caractacus	65	Fair.	Very good.	Short.	20 inch's
Kentish Invicta	68	Good.	Good.	Medium.	30-36 "
William I	65	Poor.	Fair.	Short.	18 "
Philadelphia Extra Early	65	Fair.	Good.	Short.	30-36 "
Extra Early Winship	62	Very poor.	Extra.	Short.	18 "
Dexter	64	Fair.	Very good.	Medium.	24 "
Alpha	65	Very poor.	Fair.	Medium.	6 "
Nutting's No. 1	68	Fair.	Extra.	Long.	20 "
Early Kent	74	Good.	Fair.	Medium.	40 "
Carter's First Crop	73	Very good.	Fair.	Medium.	36-40 "
Tom Thumb	68	Good.	Fair.	Medium.	12-18 "
McLean's Little Gem	66	Poor.	Poor.	Medium.	12-15 "
McLean's Blue Peter	65	Good.	Good.	Long.	36 "
Carter's Extra Early Prem. Gem	65	Poor.	Good.	Medium.	12 "
McLean's Advancer	74	Poor.	Extra.	Long.	15-18 "
Dwarf Waterloo Marrow	84	Good.	Good.	Long.	18-20 "
Eugenie	84	Good.	Very good.	Long.	36 "
Laxton's Prolific Early Long Pod	84	Fair.	Good.	Medium.	40 "
Princess Royal	84	Very good.	Good.	Long.	36 "
Napoleon	84	Good.	Good.	Long.	40 "
Yorkshire Hero	84	Good.	Good.	Long.	24-30 "
McLean's Premier	84	....	Extra.	Long.	....
Champion of England	84	Fair.	Good.	Long.	40-48 inch's
Veitch's Perfection	86	Good.	Very good.	Long.	36 "
Dwarf Blue Imperial	86	Very good.	Very good.	Medium.	36-40 "
Carter's Surprise	88	Good.	Very good.	Medium.	24-30 "
Large Gem	84	Very good.	Good.	Medium.	24 "
Omega	86	Very good.	Good.	Medium.	24 "
Laxton's Superlative	82	Fair.	Good.	Medium.	40-48 "
Black Eyed Marrowfat	82	Very good.	Poor.	Medium.	40-48 "
Our Extra Early	65	Fair.	Good.	Short.	18-20 "
Extra Early Dan O'Rourke	74	Fair.	Fair.	Medium.	36 "
Drew's Dwarf	84	Fair.	Good.	Medium.	12 "
McLean's Best of All	82	Poor.	Fair.	Medium.	30 "
Fill Basket	84	Extra.	Fair.	Medium.	24 "

These varieties of peas were planted the same day and treated alike in every respect. The qualities stated in the table will enable any one to choose good varieties. The soil was sandy loam in fair condition.

FARM EXPERIMENTS.

These have been conducted on the same plan as heretofore with the greatest care and attention to detail. Some of the results are very interesting and offer practical suggestions, if not specific lessons.

FIELD CORN.

Several varieties of Dent corn were planted, concerning which nothing new was developed.

Canada Early Yellow Flint was the first variety to mature, ripening so much earlier than all others that it seems as if it could not fail in the shortest season. The ears are small (8 rowed) and of medium length, but the stalks are also small and the hills may stand closer together than with the larger varieties.

Compton's Early Field was planted for the first time. It was planted on soil which the drouth affected seriously. It did no better than any other variety would have done under the same circumstances.

One of those facts more curious, perhaps, than important, was observed in connection with the field corn this year. The Canada Early Yellow Flint is a well established variety with eight rows of kernels to each ear. But in the crop of 1876 one ear was found with 12 rows of kernels. This was saved and planted, but not one single kernel grew, although the eight rowed corn from the same crop, planted close by, showed no failure at all.

TURNIPS FOR STOCK.

Planted on sandy soil in poor condition. The varieties were all obtained from Wm. Rennie, Toronto, Ca. The following figures show the yield per acre (in bushels of 60 lbs.) of each variety:

Carter's Imperial Purple Top Swede	444.6	Bushels.
Lang's Improved Purple Top Swede	327.6	"
Rennie's Prize Purple Top Swede	323.1	"
Skirving's Improved Purple Top Swede	294.3	"
Green Top Swede	284.3	"
Yellow Aberdeen Green Top	37.5	"
Yellow Aberdeen Purple Top	44.7	"
Green Globe	106.1	"
Norfolk Globe	111.3	"
Red Globe	152.6	"
Greystone	116.0	"

TWENTY-THREE VARIETIES OF POTATOES.

Planted on sandy soil in poor condition May 8th. This late planting was caused by the fact that many of the varieties were shipped from the East after danger of freezing had passed. The seed was cut to a single eye and dropped in a furrow made by the plow, at intervals of ten to 12 inches one eye in a place. The seed

was then partially covered with the plow and the fertilizer dropped on this covering. The covering was then completed. All varieties received the same kind and quantity of fertilizer. The low yield per acre is explained by the conditions of the soil, the late planting and the unusual drouth.

Name of Variety.	Seed per acre.	Yield per acre.	Yield per acre.
	Bushels.	*Large Bush.*	*Small Bush.*
Peerless	8.7	84.4	8.7
Shaker Fancy	8.4	48.9	5.6
Eureka	8.0	77.6	10.2
Late Rose	7.9	70.1	9.4
Little Giant	7.5	69.2	8.0
Excelsior	7.2	48.5	16.0
Dunmore's Seedling	7.0	99.3	12.2
Calcutta Seedling	6.9	92.2	8.7
Paragon	6.6	45.4	18.2
Fluke	7.4	67.6	7.9
Burbank's Seedling	7.4	80.5	15.4
Cayuga Chief	6.0	50.0	9.6
Victor	8.0	91.3	13.4
Brownell's Beauty	5.8	65.7	4.2
Snowflake	6.3	67.0	20.7
Extra Early Vermont	6.5	70.4	14.3
Ruby	5.3	65.4	10.9
Improved Peachblow	5.3	9.8	4.9
Superior	5.3	9.2	2.8
Centennial	5.3	28.3	3.5
Early Rose	5.3	36.0	17.3
Alpha	5.3	24.0	12.0
Early Ohio	5.3	55.9	13.8

VARIETIES OF WHEAT.

The following eight varieties were sown April 30th, on sandy loam, in very poor condition. The plats were 549 feet long and 20 feet wide, and contained a little more than one-quarter acre. The seed was sown with a seeder, and it was intended to sow equal quantities, but some kinds having smaller kernels than others ran through faster. Hence the difference in the quantities sown. There was no appreciable difference in the time of ripening. The seed of all except the last variety was grown on the State Experimental Farm in 1876. The Touzelle was received from the U. S. Department of Agriculture. The following table shows the seed sown and the yield of grain and straw per acre:

	Seed per acre.	Grain per acre.	Straw per acre.
	Lbs.	*Bushels.*	*Lbs.*
Golden Globe	95	11.7	1,440
Fife (seed from Canada, 1876)	87	12.9	908
Dominion	87	9.9	1,123
Mediterranean	87	11.2	1,285
Rio Grande	87	12.7	1,349
Fife (Minnesota seed)	87	13.5	1,436
White Fife	103	11.4	1,277
Touzelle	77	3.2	1,059

The following varieties were also sown but not in quantities to permit of accurate measurement. The Egyptian is a variety with a somewhat branching head. The grain was of fine appearance, but the yield apparently quite low.

The Arnotka is a variety with a square head and very long beards. The yield was not large and the grain was prononnced too hard for flouring purposes.

The Oran gave a very small quantity of poor shrunken grain. Two previous trials with this variety gave similar results.

The Lost Nation apparently gave a larger yield than any other variety sown.

China Spring, Canada Club and Golden Drop showed nothing requiring particular mention.

VARIETIES OF OATS.

The following varieties of oats were sown on similar soil, and in the same manner as the varieties of wheat in the above table, with the results stated in the table:

	Seed per acre.	Grain per acre.	Straw per acre.
	Lbs.	*Bushels.*	*Lbs.*
Silver White Queen	79	23.5	1,083
White Schonen	86	29.6	1,246
Canadian	99	33.4	1,190
Brunswick	83	29.6	1,408
Waterloo	99	24.1	1,194
Black Norway	71	32.5	1.408
Probsteir	79	32.5	1,380
Excelsior	91	25.4	1,142
Chinese Hulless	64	11.1	1,051
White Dutch	117	26.9	1,111

The seed of Probsteir and Chinese Hulless were obtained from B. K. Bliss & Sons; The White Dutch from U. S. Department of Agriculture, the seed of the other varieties was grown on the State Experimental farm in 1876.

FERTILIZERS ON WHEAT.

Fertilizers were tested on wheat with data and results as given in the following table. The soil was similar to that described above for wheat, and the manner of sowing the wheat the same. The fertilizers were then sown broadcast by the hand and mixed with the soil by a double stroke of the harrow. The difference shown by the figures could be seen in the plats any time after heading out, and bundles were shown at the State Fair showing the same difference very distinctly, save that the guano appeared nearly as good as the Stockbridge manure:

Name of Fertilizer.	Quantity per acre	Cost per acre	Cost of Freight per acre.	Total cost. per acre.	Grain per acre	Straw per acre	Increase per acre, Grain.	Difference per acre, Straw.
					Bus	Lbs.	Bus.	Lbs.
Rectified Guano	505 9 lbs	$16.42	$5.05	$21 47	16 5	1,827	5 1	*607
Stockbridge Manure for Wheat	458 2 lbs	15.83	4.58	20.41	20 1	2,232	8 7	*1,012
No Manure					11 4	1,220		..
Superphosphate	892 2 lbs	14 76	8.57	23.33	16 1	1,571	4 7	*351
Ashes	35 7 bus	5.35	..	5.35	11 9	1,113	0 5	†107
Gypsum	505 2 lbs	4 46		4.46	11 4	1,136	..	†84

*Increase
†Decrease

FERTILIZERS ON POTATOES.

Fertilizers were tested on potatoes with data and results as given in the following table. For description of soil, manner of planting, manner of applying fertilizer, and causes of low yield per acre, see "Varieties of Potatoes" on a preceding page.

Name of Fertilizer	Quantity per acre.
Rectified Peruvian Guano	381 9 lbs
Stockbridge Man for Potatoes	424 7 lbs
No Manure	
Superphosphate	762 1 lbs
Ashes	33 bus
Gypsum	637 3 lbs

*Increase.
†Decrease.

FARM CROPS.

Eighty-six bushels of oats were harvested. The hay crop is estimated at 45 tons, about 20 of which have been sold (Dec. 1,) mostly in the stack at $7 per ton. The season so favored the making that it was put up in perfect condition and the care taken in stacking has prevented subsequent injury. From the farm experiments were obtained in addition to above 30 bushels of wheat, 40 bushels of oats, 150 bushels of corn (ears), and 75 bushels of potatoes.

IMPROVEMENTS.

Fifty-two elms have been set on either side of the University Avenue, where they were set and failed to grow two years since. Every reasonable precaution was this time taken to insure their life and growth. The method may be a guide to others under similar circumstances, and is therefore worthy of description. It was necessary to get rid of excessive moisture and to secure a suitable soil, the natural one being a stiff peat saturated with water, unfit to sustain the growth of anything but ferns and wild grasses. An elevated site was secured for each tree by digging a ditch 12 to 18 inches deep and 24 to 30 inches wide, around a circular plat ten feet in diameter, throwing the sods and dirt upon this plat, raising it high at the margin and leaving a deep depression in the center. In setting the trees a small load of sandy loam was hauled for each tree. A portion of this was placed in the depression mentioned above, as a sort of bed. On this the tree was set and the remaining soil was placed and packed about the roots. The trees were then thoroughly mulched with old hay the entire elevation being nearly covered to a depth of four or five inches. This mulch preserved the moisture so perfectly that moist soil could easily be reached with the toe of the boot when other trees were dying for want of water. After mulching, to prevent loosening of the roots by swaying of the tops in the wind, the trees were supported by driving stakes in the ground about two feet from the tree but inclining so that the top of the stake crossed the trunk of the tree four or five feet from the ground where the one was tied to the other. The trees themselves were obtained not from the forest, but from the nursery, where they were said to have been transplanted three times, by which the growth of roots had been kept close to the foot of the trunk where they could be easily retained with the tree, furnishing it with organs of support from the first. None were more than one and a half inches in diameter. In pruning, the tree was not cut off below the branches, but the latter were all cut back severely and a portion cut out entirely. The result of this pruning was, not a bean pole, but a tree as soon as growth commenced.

The success of this method must be its test, and it only remains to say that not more than five of these trees failed to live, and make a growth of four to ten inches. Forty four European Larches were set alternating with these elms, but owing to conditions already stated only three or four survived.

A shed, the parts of which were removed from the University Campus some two years ago, has been put together, and is now used for the protection of implements, all of which it enables us to house easily and perfectly.

Some breaking has been done. One piece lying on north side of Avenue, and in the angle made by Avenue and east line of farm, containing about one acre. Another piece lying on south side of Avenue and adjacent thereto, containing about eight acres.

PLANT HOUSE.

This presents a very satisfactory condition. The plants are as yet mostly of the common kinds of greenhouse plants, but a few of economic value in other climates are there also. More than forty natural orders and fifty genera are represented by 900 individuals. The health and vigor of the plants have always received favorable comment from visitors. Since the first of April, the work has been performed by Mr. Geo. A. Wood, a student, member of the senior class, and to his industry, faithfulness and intelligence the credit for this condition of the plant house is largely due.

As was believed it would, the plant house has been found a valuable assistance by the instructors in botany, the more so as the University is without the botanical models possessed by many institutions. Its value in this line will increase as its collections become more varied. The plant house has also contributed somewhat to the adornment of the University grounds and will contribute more largely when the latter are properly enclosed.

STATE FAIR.

As in former years the Agricultural Department of the University made such exhibit at the State Fair as its materials permitted, and aided by past experience the exhibit was made no less creditable. The following is a brief enumeration of the articles and description of their arrangement:

From the State Experimental Farm, grown in the season of 1877.

Ten varieties oats, fifteen varieties spring wheat, three varieties barley, one variety spring rye, one variety field peas, thirty-five varieties garden peas, twenty-two varieties beans, fourteen varieties grass, six specimens wheat showing effect of manures, ten varieties sweet and pop corn, and four varieties field corn. Also twenty-four varieties potatoes, six boxes potatoes showing effect of manures, eighteen varieties tomatoes, eleven varieties squash, two varieties egg plant, three varieties pumpkin, three boxes gourds, four varieties cucumbers, eighteen varieties garden and field beets, and seven varieties carrots.

From the Museum of Agriculture.

Thirty-three varieties grass and clover seeds, eight varieties winter wheat, five varieties oats, peas and corn, and twelve kinds of fertilizers.

From the Agricultural Class Room.

Map of State Experimental Farm, map of the Forest Area of the United States, colored lithographs of Walter Cole's flock of merino sheep and herd of Devon cattle, and lithograph of C. A. DeGraff's herd of Alderny cattle.

From the University.

Painting of University Building, a diagram showing the relation of the University courses of study to the State System of public schools, and a copy of the diploma issued to graduates of the University. Also in this line an oil painting of "Experience Oaks." from Hon. Wm. S. King.

From the University Plant House.

Sixty-five plants, embracing Coleus. Pelargoniums. Calla, Oxalis, Photinias, Pandanus. Begonias, Alternthera, Cacti, Fuchsias, Agaves.

The corn was braided by means of the husks into strings and hung together with the pictures, on the walls above the tables on which the other articles were arranged. Each variety of wheat, oats, barley and rye was represented by two specimens. One, a small sheaf of grain in the straw; the other, a pailful of threshed and well cleaned grain.

Beginning at the left 26 bundles, varieties of wheat oats and rye, stood upright, in a row, at the back of the table, against the wall. In front of these, a row of 26 pails containing the corresponding varieties of threshed grain. In front of these, at the margin of the table stood a row of shallow boxes, containing tomatoes, cucumbers, squashes, etc. To the right of all these the fourteen varieties of grasses stood on a frame against the wall, while a group of vegetables occupied the front. Still farther to the right, a raised table held the articles from the museum and the beans and peas in jars. To the right of this table the rows of bundles, pails and boxes recommenced. At the back six bundles of wheat grown with different fertilizers, and three varieties of barley. In front of these the corresponding pails of grain, and at the margin of the table, six boxes containing the potatoes grown with different fertilizers on equal areas. Finally a raised table containing specimens from the plant house. The twenty-four boxes of potatoes containing the products of different varieties on equal areas occupied another table.

The exhibit was arranged with a view to making it instructive. Both the arrangement and the quality of the articles were subject of frequent and favorable comment. The judges on the flowers reported as follows:

Division H—Supplementary Report.

"The exhibit of greenhouse plants from the State University being entirely apart from the other exhibits in this class was overlooked by the committee until after the above main report was made out.

Theyh ave, however, examined it, and take pleasure in reporting that the collection though not wide in variety deserves honorable mention from the general fine and healthy condition of the plants. This like other exhibits of the University was not entered as competing for premiums. The committee would respectfully suggest that it would be well for the University to cultivate the best varieties of flowering plants peculiar to the State, as many of them may otherwise become extinct.

[Signed.] "A. D. Roe.
"Mrs. G. W. Chowen,
"Mrs. Judge Atwater."

This supplementary report was made without the knowledge of any one connected with the University.

Several requests for samples were received and complied with as follows:

Milo J. Smith, Smith's Ferry, Mass., complete set of the grains for exhibition at a county fair, and subsequently to place in the office of Secretary of Massachusetts Board of Agriculture.

W. H. Ritter, Inspector for the Millers' Association, complete set of wheat and oats.

Hon. Geo. A. Bracket, complete set of grains to send east for exhibition.

J. A. Christian & Company, Minneapolis, complete set of wheats.

Many others received small quantities for seed.

The week following the State Fair, the grain and potatoes were taken to Stillwater for exhibition at the Washington County Fair, the Washington Co. Agricultural Society paying freight and drayage. The attendance at this fair was not large, but the Agricultural College exhibit attracted its full share of attention, and much interest was shown in some of the articles.

At the State Fair of 1876 entries were made and diplomas representing the highest premiums of the Society were awarded for the "largest and best display of vegetables," and for "large and choice display of grain and seeds." These diplomas have been received, framed and hung on the walls of the agricultural class room.

CAMPUS.

In the autumn of 1876 the executive committee of the Board of Regents directed the undersigned to assist the President of the University as superintendent of the campus. Under his directions several small changes have been made that have contributed much to an improved appearance. A portion of the elevation immediately in front of the main building has been removed to fill depressions near the same. The shifting and barren sand immediately in front of the agricultural building has been covered with better soil. The path between the two buildings has been raised to a sort of turnpike where it passes through a hollow frequently filled with water. In July the mowing machine was passed over the entire campus, improving its appearance, and contributing to the thick-

ening of the grass. In September the weeds that afterwards sprung up were cut with a scythe. About the first of November the leaves on the campus were raked into large piles and burned. A gravel walk has been made from University Avenue to the front entrance of the main building. The appearance of the agricultural building was improved during the summer by spading and manuring the soil in the angles of the building and removing thereto a large portion of the plants from the plant house.

LABOR.

The faithful assistance in the plant house of Mr. Geo. A. Wood has already been mentioned. On the first of April last Mr. W. T. Scott withdrew from the service of the University and the place of farmer was taken by Mr. J. B. Eustis, a former student of the University. Mr. Eustis has brought to bear upon his duties every quality that could render his services acceptable, and the only cause for regret is that he will not consent to continue them. The labor under my direction has been performed more largely by students this year than heretofore, and it gives me great pleasure to testify to their general faithfulness and efficiency. The whole sum paid for labor under my direction on the farm, the campus and in the plant house, from Dec. 1, 1876, to Nov. 30, 1877, was $1716.93. Of this $736.14 was paid to more than 32 different students in sums ranging from 75 cents or less to $224.30.

CHAS. Y. LACY.

APPENDIX B.

LIST OF BOOKS

ADDED TO

THE LIBRARY

OF THE

UNIVERSITY OF MINNESOTA,

COMPLETE TO APRIL, 1878.

NOTES.

1. Whenever a work is received at the Library, it is entered in the so-called "Accession Register," under these headings: Date, accession number, short title, published when and where, number of volumes, size, number of pages, condition, received from or through, value or cost, gift, shelf number. Gift books are also entered in a "Donation Register."

2. The volumes then receive their proper labels and numbers, and the catalogue slips having been written out, they are ready for delivery to readers.

3. Each work in this catalogue has accordingly two numbers; first, the accession number, and secondly, in heavy faced type, the shelf number. Readers in calling for books, must put down the latter number correctly pointed and designate *the volume;* and it is also desirable that the accession number be given.

4. The system of shelf marking will be readily inferred from examples. 364.13, indicates the thirteenth *work* on the fourth shelf, of case or press No. 36. To find the work "pressmarked" 76.8, go to to press number 7 and look on the 6th shelf—counting from the floor upwards—and for the 8th work, numbering from the left hand.

5. The abbreviations are those customary in similar lists, and are mostly self-explanatory.

LIST OF BOOKS ADDED TO LIBRARY---COMPLETE TO APRIL, 1878.

Abel, F. A. and Bloxam Charles. L. Hand-Book of Chemistry, Theoretical, Practical, and Technical, with a preface by Dr. Hoffman. * * * London: John Churchill, . . . 1854. 8°, pp. xix.+724. (5377)........**462.11**

Abercrombie, John, . . . Inquiries concerning the Intellectual Powers, and the Investigation of Truth . . . From the last Edinburgh edition. New York: Harper & Brothers. 12°. pp. 376. (H. F. L., No. 37.) (4868).**386.29**

Abercrombie, John. . . . The Philosophy of the Moral Feelings. . . . From the last Edinburgh Edition, with questions for the examination of students. New York: Harper & Brothers . . . 1848. 12°, pp. 336. (H. F. L. No. 58.) (4880)..**387.12**

Achard, Amédée et Deslys, Charles. Le Clos-Pommier, Drame en cinq Actes * * * Paris: Michael Levy Frères . . . 1865. 8° pp. 94. (4696).....**118.6**

Acts of Stephen, King of England and Ruler of Normandy. 12°, 100 pp. *See* Henry of Huntingdon. Chronicle of ——, p. 320. (5122).....**376.4**

Adam, Alexander. ... Roman Antiquities: or An Account of the Manners and Customs of the Romans; with numerous Notes and improved Indices. By James Boyd. ... Illustrated by upwards of 100 Engravings on Wood and Steel. By Lorenzo L. Da Ponte. ... Philadelphia: J. B. Lippincott & Co., 1872. 8°, pp. xii.+439. (5025)..........................**227.13**

Adams, George. ... Lectures on Natural and Experimental Philosophy. The second edition, with considerable corrections and additions, by William Jones, ... London: 1799. ... W. and S. Jones. ... 5v. 8°. (5293)..**464.5**

Contents—Vol. I. Pneumatics, Acoustics, Heat, Gases, pp. 31 : 592.
" II. Water, Optics, Catoptrics, Telescopes, Microscopes, pp. 8 ; 576.
" III. Matter, Mechanics, Hydrostatics, Specific Gravity, Hydraulics, Astronomy, pp. 7 ; 583,
" IV. Copernican System, Physical Astronomy, Electricity, Meteorology, pp. 8 ; 576.
" V. General Index, References to plates, Plates, pp. 45 ; 42 plates.

Adams, Samuel. Extracts from Correspondence, Political Essays and State Papers. *See* Wells, W. V. Life and public services. (5479).....**395.19**

Addis, Alfred. . . . [Questions. 38 pp. 12°] *See* Combe, Andrew. Principles of Physiology, at p. 358. (4889)......................**387.21**

Addison, Joseph. Criticism on Milton's Paradise Lost. ... Carefully edited by Edward Arber. . . . London. . . . 152 pp. 16° (*English Reprint.*) (5107)..**384.7**

ADDISON, Joseph. *See* Selections from the Spectator. (4961) 38X.9

ÆSCHYLUS. The Prometheus Bound. Edited, with English notes, critical and explanatory, by the Rev. James Davies ... * * * London: Lockwood & Co. .... 1871. 12° pp. x.+91. (5131) ("From text of Dindorf's third edition.") 258.25

ÆSCHYLUS. The Prometheus Vinctus, from the text of Dindorf, with notes by the Rev. John Selby Watson. ... * * * Williams and Norgate, ... London ... 1870. 8°, pp. viii.+132+8. (4622) 147.19

AGASSIZ, Louis. [Jean Rudolph.] Contributions to the Natural History of the United States of America ... Boston: Little, Brown & Company, 4v. 4°. 1857-'62. (5480) ....*

Contents :—Vol. I. Essay on Classification, pp. 323. North American Testudinata, 130 pp. at p. 333.
Vol. II. Embryology of the Turtle, 643 pp. & 34 plates.
Vol. III. Acalalephs in general, 152 pp. Ctenoporae, pp. 148, explanation of plates, 15 pp. & 19 plates.
Vol. IV. Discophorae, 180 pp. Hydroidae, 191 pp. Homologies of the Radiata, 8 pp. Ex. of plates, 12 pp. 16 plates.
Vols. I. & II. contain the first monograph; Vols. III. & IV. the second monograph.
Presented by Mrs. M. F. Pierce, of Cambridge, Mass.

AGASSIZ, Louis. [Jean Rudolph.] The Classification of Insects from Embryological data. 4°, pp. 28+1 plate. *See* Smithsonian Institution, Contributions to Knowledge, Vol. II. (1851) Art. 6. (5482) 441.1

AINSLIE, Whitelaw ... [Medical Observations.] *See* Murray, H. [and others.] Historical and Descriptive Account of British India, Vol. III. p. 258. (4873) 387.5

AINSWORTH, William Francis. Travels in the Track of the Ten Thousand Greeks; Being a Geographical and Descriptive Account of the Expedition of Cyrus, and of the Retreat of the Ten Thousand Greeks, as related by Xenophon. London: John W. Parker, 1844. 8°, pp. xv.+248.+map. (4631) 258.33

AIRY, George Biddle. ... A Treatise on Magnetism. Designed for the use of Students in the University. London: Macmillan & Co. 1870. ... 16°, pp. xv+220. (5429) ....466..20

AKERS, Peter. ... Introduction to Biblical Chronology, ... * * * Cincinnati: ... Methodist Book Concern, ... 1856. 8°, pp. 411. (5285) 395.6

ALFRED, *King*. [Translator] *See* Boethius de Consolatione Philosophiae. 16°, pp. 398. (5109) 376.12

ALGER, Francis. [Additions] *See* Phillips, W., Mineralogy. (4797) 462.9

ALISON, Archibald. ... History of Europe from the Commencement of the French Revolution in 1789, to the Restoration of the Bourbons in 1815. New York, ... Harper & Brothers. ... 1847-8. 4v. 8°, pp. 583, 600, 612, 631. (4818) 372.3

ALLAINVAL, Léonore Jean Christine *de* [L'Ecole des Bourgeoises, pp. 63. Memoir.] *See* Chefs-d'oeuvres des Auteurs Comiques, Vol. III. (5090) 118.13

ALLAN, Robert. [Editor] *See* Phillips, W., Treatise on Mineralogy (4797) 462.9

ALLEN, A. B. ... [Editor.] *See* Stewart, Stable Economy, (5265) ..516.16

Allen, David O. ... India Ancient and Modern. Geographical, Historical, Political, Social, and Religious; with a particular account of the State and Prospects of Christianity. Boston: John P. Jewett and Company, ... 1856. 12°, pp. xii.+618. (4547) (*Missionary to India*, 1827-1853.).......157.1

Allen, H. ... Monograph of the Bats of North America. 110 pp. 8°. *See* Smithsonian Institution, Miscellaneous Collections, Vol. VII. (1867) Art. 1. (5506)..443.1

Allen, Paul. [Editor.] *See* Lewis, M. and Clarke, W., History of the Expedition under the command of. (4940)............................389.19

Allen, William. [Diary and Correspondence, Selections from.] *See* Life of. 2v. 8°. (4602)..147.3

Allouard, H. [Illustrations.] *See* Fournier, M. E., Le Theatre Francais. ...

Alvord, Benjamin. The Tangencies of Circles and of Spheres. 4°, 16 pp. +1 plate. *See* Smithsonian Institution, Contributions to Knowledge, Vol. VIII. (1856) Art. 4. (5488)..........................441.1

American Adventure by land and Sea; Being ... Shipwrecks, Adventures at Home and Abroad, Indian Captivities, &c. ... New York: Harper and Brothers, ... 1847. 2v. 12° ... (H. F. L. No. 174-5) (4956)...38X.4

American Journal of Science and Arts. *See* Silliman B. (4591) **

American Quarterly Observer, the; Vols. I. and II. in one. Boston: 1833-34. (4545)...157.5

Ames, Mary Clemmer. [Eirene; or a Woman's Right. 219 pp. 8°.] *See* Putnam's Magazine, new series, Vol. VI., Supplement, p. 569. (5235)

Andreas, A. T. [Publisher.] An Illustrated Historical Atlas of the State of Minnesota. ... Chicago: ... 1874. f. pp. 395. (7 pp. Index, &c., pp. 8-190, maps and views; 181-206½, portraits of public men; 207-end. history and statistics.) (5279)..............................Cabinet B.

Antietam National Cemetery, History of, including a Descriptive List of all the Loyal Soldiers buried therein: together with the Ceremonies and Address on the Occasion of the Dedication of the Grounds, September 17th, 1867. Baltimore, ... John W. Woods, ... 1869. 8°. pp. 202+2 photographs +map. (4836)....................................381.13

Antoninus, Marcus Aurelius. The Thoughts of ... translated by George Long. * * * Boston: Ticknor & Fields, 1864. 12°, pp. 310 (5223)..377.4

Memoir of author at p. 7. Account of his philosophy, p. 36. "This little book of Antoninus has been the companion of some great men." *Translator.*

Arber, Edward. [Editor.] *See* Ascham, Roger. Toxophilus. ... (5108)..384.5

——— [Editor.] *See* Pultenham, G. The Arts of English Poesie. (5106)..384.6

——— [Editor.] *See* Addison, Joseph. Criticism on Milton's Paradise Lost. (5107)..384.7

Aristoteles, The Ethics of. Edited by William Edward Jelf, ... Oxford, and London: John Henry and James Parker. 1856. 8°, pp. 240. (4615) 147.18

Armstrong, H. E. ... [Phenols, p. 900; Sulphur and Chlorides, p. 1129.] *See* Watts, H. Dictionary of Chemistry, Second Supplement (4551.)

Armstrong, John. ... Lectures on the Morbid Anatomy, Nature, and Treatment of Acute and Chronic Diseases. Edited by Joseph Rix. ... Philadelphia: Haswell & Barrington. ... 1837. 8°, pp. 687+20. (4786)...**371.18**

Armstrong, John. Life of Richard Montgomery. 45 pp. 12°.+facsimile. *See* Sparks, J. Lib. Am. Biog., Vol. I., at p. 181. (4814).........**385.1**

Armstrong, John. Life of Anthony Wayne. 12°, pp. 84.+facsimile. *See* Sparks, J. Lib. Am. Biog., Vol. IV. at p. 1. (4814)..............**385.1**

Arnold, Thomas Kerchever. ... [Editor.] *See* Madvig, J. N., Syntax of the Greek Language. (4624)..................................**258.35**

Ascham, Roger. Toxophilus, 1545. Carefully edited by Edward Arber. ... London: Alex. Murray & Son. ... 1868. ... 16°, pp. 168. (*English Reprints.*) (5108).......................................**384.5**

Asser *of St. Davids.* Annals of the reign of Alfred the Great, from A. D. 849 to A. D. 887. 43, pp. 12°. *See* Giles, J. A. [Editor.] Six Old English Chronicles, at p. 43. (5117)..............................**376.9**

Aubigne, Jean Henri Merle *de*. ... History of the Great Reformation of the Sixteenth Century, in Germany, Switzerland, etc. New York: William H. Colyer. ... Boston: Phillips & Sampson, 1846. 8°, pp. xiv.+499. (4970)...**381.17**

Audrieux, François Guillaume Jean Stanislas. [Les Etourdis, ou le Mort supposi. pp. 57.— Le Reve du Mari, ou le Manteau, p. 59—Thoughts of Anaxamandre, ou le sacrifice au Graces, p. 99. (Memoir.)] *See* Chefs-d'Oeuvres des Auteurs Comiques. Vol. VII. (5090).............**118.13**

Aurelius, Marcus [Antoninus.] *See* Antoninus, M. A. (5223).......**377.4**

Austen, Jane. ... Mansfield Park. A Novel. Boston: James R. Osgood & Company, ... 1876. 12°, pp. 431. (5064)..................**456.20**

Austen, Jane. ... Pride and Prejudice and Northanger Abbey. Philadelphia: Porter & Coates. ... 12°, pp. 528. (5222) (Northanger Abbey begins at p. 321.)..**377.7**

" . . . There are in this world no compositions which approach nearer to perfection." *Macaulay.*

Axon, William E. A. .... The Mechanic's Friend; a Collection of Receipts and Practical Suggestions relating to Aquaria, ... Waterproofing, and Miscellaneous Tools, Instruments, Machines, and Processes connected with the Chemical and Mechanical Arts. With numerous diagrams and wood Cuts. New York: D. Van Nostrand. 1875. 16°, pp. xii.+339. (5037)...**148.14**

Bache, Alexander Dallas. Discussion of Magnetic and Meteorological Observations made at the Girard College Observatory, Philadelphia, in 1840, 1841, 1842, 1843, 1844 and 1845. Part 1. Investigations of the eleven year period in the amplitude of the solar diurnal variation and the disturbances of the magnetic declinations. 4°, pp. 22 ... *See* Smithsonian Institution, Contributions to Knowledge, Vol. XI. (1859) Art. a. 4. (5491).....**441.1**

Bache, Alexander. Discussions of the Magnetic Meteorological Observations made at the Girard College Observatory, Philadelphia, in 1840, 1841, 1842, 1843, 1844, and 1845. Part II. Investigations of the solar diurnal variation of the magnetic declination and its annual inequality. 28 pp. Part III. Investigation of the lunar effects of the magnetic declination. 16 pp. Parts IV., V., VI., Horizontal Force. Investigation of the Ten or Eleven Year Period, and of the disturbances of the Horizontal Component of the Magnetic Force; Investigation of the solar diurnal variation and of the annual inequality of the Horizontal Force, and of the lunar effects on the same. 78 pp. Records and results of a Magnetic Survey of Pennsylvania and parts of adjacent States, in 1840 and 1841, with some additional records and results, of 1834, 1835, 1843, and 1862, and a map. 88 pp.+1 map. *See* Smithsonian Institution, Contributions to Knowledge, Vol. XIII. (1863) Arts. 5, 6, 7, 8. (5493) **441.1**

Bache, Alexander Dallas. Discussion of the Magnetic and Meteorological Observations made at the Girard College Observatory, Philadelphia, in 1840, 1841, 1842, 1843, 1844, and 1845. Third Section, comprising Parts VII., VIII., and IX. Vertical Force. Investigation of the Eleven (or Ten) Year Period, and of the annual inequality of the Vertical Force; and of the lunar effect of the Vertical Force, the Inclination, and Total Force. 72 pp. Fourth Section, comprising Parts X., XI. and XII. Dip and Total Force; Discussion of the solar diurnal variation and annual inequality of the Dip and Total Force; and discussion of the Absolute Dip, with the final values for Declination, Dip and Force between 1841 and 1845. 44 pp. 4°. *See* Smithsonian Institution, Contributions to Knowledge, Vol. XIV. (1865) Arts 3&4(5494) **441.1**

Back, *Captain* [George.] Narrative of the Arctic Land Expedition to the mouth of the Great Fish River, and along the shores of the Arctic Ocean, in the years 1833, 1834, and 1835. Illustrated by a map. Second Edition. Philadelphia: E. L. Carey & A. Hart. . . . 1837. 8°, pp. 456.+map. (5204)..**391.11**

Bacon, Francis, . . . Essays, Moral, Economical, and Political, . . . with an Introductory Essay on Bacon and Locke, by A. Potter, D. D. . . . New York: Harper & Brothers, . . . 1847. 12°, pp. 299. (H. F. L., No. 171) (4953)..**38X.1**

Locke on the Understanding in same vol. p. 209.

Baecker, Louis *de*. Grammaire Comparée des Langues de la France. * * * Paris: Ch. Blériot, . . . 1860. 8° pp. 267. (5091)...........**108.2**

Bailey, Jacob Whitman . . . Microscopical Examinations of Soundings made by U. S. Coast Survey of the Atlantic Coast of the U. S. pp. 16+1 plate. *See* Smithsonian Institution, Contributions to Knowledge, Vol. II. (1851) Art. 3. (5482)..**441.1**

——— . . . Microscopical Observations made in South Carolina, Georgia and Florida. 4°, pp. 48+3 plates. *See* Smithsonian Institution, Contributions to Knowledge, Vol. II. (1854) Art. 8. (5482)....................**441.1**

——— . . . Notes of New Species and Localities of Microscopical Organisms. 4°, pp. 16+1 plate. *See* Smithsonian Institution, Contributions to Knowledge, Vol. VII. (1855) Art. 3. (5487)....................**441.1**

Baird, James Skerrett . . . The Homeric Dialect; Its Leading Forms and Peculiarities. London: George Bell, . . . 1853. 8°, pp. 28. (4614)...**258.37**

BAIRD, Spencer Fullerton. Catalogue of American Birds, chiefly in the Museum of the Smithsonian Institution. 1859. 8°, 24 pp. *See* Smithsonian Institution, Contributions to Knowledge, Vol. II. (1872) Art. 4. (5501)........**443.1**

—— Directions for collecting, preserving, and transporting specimens of Natural History. . . . 8°, 40 pp.. *See* Smithsonian Institution, Miscellaneous Collections, Vol. II. (1862) Art. 7. (5501)................**443.1**

—— Questions relative to the Food Fishes of the United States. 7 pp. Memoranda of Inquiry relative to Food Fishes of the United States. 5 pp. *See* Smithsonian Institution, Miscellaneous Collections, Vol. X. (1873) Art. 8. (5509)..**443.1**

—— Review of American Birds, in the Museum of the Smithsonian Institution. Part I. 1864-1872. 8°, pp. 484. *See* Smithsonian Institution, Mislaneous Collections, Vol. XII. (1874) Art. 1. (5511)................**443.1**

BAIRD, Spencer Fullerton, and Girard C. Catalogue of North American Reptiles in the Museum of the Smithsonian Institution. Part I. Serpents. 1853. 8°, 172 pp. *See* Smithsonian Institution, Miscellaneous Collections, Vol. II. (1862) Art. 4. (5501)...**443.1**

BAMBER, Edward Fisher. [Revisions.] *See* Rankin, W. J. M., Mechanical Text Book—Manuals of Machinery, Steam Engine, and Applied Mechanics.

BARDSLEY, Charles Wareing . . . English Surnames: their Sources and Significations. * * * Second Edition, revised and enlarged. London: Chatto and Winders . . . 1875. 16°, pp. xvi.+612. (5457)..........**377.12**

BARNARD, John G. Problems of Rotary Motion presented by the Gyroscope, the Precession of the Equinoxes, and the Pendulum. . . . 74 pp. 4° *See* Smithsonian Institution, Contributions to Knowledge, Vol. XIX. (1874.) Art. 2. (5499)..**441.1**

BARNARD, Henry. . . . School Architecture; or Contributions to the Improvement of School-Houses in the United States. Second Edition. New York: . . . A. S. Barnes & Co. 8°, pp. 383+frontispiece. (4817)....**394.6**

BARNABAS, Saint, Catholic Epistle of. 33 pp. 8°. [Translated.] *See* Wake Wm., Genuine Epistles of the Apostolical Fathers, p. 289. (4799).**371.11**

BARON. *See* Boyron, M.

BAROT. *See* Odysse-Barot.

BARROW, John. . . . Voyages of Discovery and Research within the Arctic Regions, from the year 1818. . . . Abridged and arranged from the Official Narratives, with occasional Remarks. New York: Harper & Brothers, . . . 1846. 12°, pp. 359+maps. (Harper's New Miscellany, XIII. (5321)..**375.10**

Contents :—Ross, p. 25 ; Buchan, p. 49 ; Parry (first voyage), p. 62 ; Clavering & Sabrin, p. 94 ; Parry (2nd voyage), p. 107 ; Lyon, p. 153 ; Parry (3d voyage), p. 166 ; Parry (4th voyage), p. 197 ; Franklin & Richardson, p. 229 ; same, p. 279 ; Bach, p. 330 ; Miscellaneous, p. 344. (inc. Thomas Simpson's and Ross's 2d voyage.)

BARROW, John. . . . A Memoir of the Life of Peter the Great. New-York: Harper & Brothers. . . . 1848. 12°, pp. 320+portrait of Peter. (H. F. L. No. 65.) (4886)....: **387.18**

BARRY, Herbert. Russian Metallurgical Works. 16°, p 1. *See* Half Hour Recreations in Popular Science, at p. 406. (5026)..............**148.17**

BARTHE, Nicolas Thomas. [Les fausses Infidélitis. 31 pp. 12° (Memoir.)] *See* Chefs-d'Oeuvres des Auteurs Comiques. Vol. VI. (5090).........118.13

BARTLETT, William H. C. . . . Elements of Analytical Mechanics, Eighth Edition, revised, corrected, and enlarged. A. S. Barnes & Company, New York and Chicago. 1873. 8°, pp. 510. (5039)..............227.9

BARTLETT, William H. C. . . . Elements of Synthetic Mechanics. Sixth Edition, revised and corrected. A. S. Barnes & Co., New York . . . 1871. 8°, pp. 632. (5040)..227.8

BARTSCH, Karl. Chrestomathie Provençale accompagnée d'une Grammaire et d'une Glossaire—Troiseème édition, revue et corrigée. Elberfield. R. L. Friderichs. . . . 1875. r 8°, pp. 590. (4625)..................1·57·8

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  ——— Survey of the Territories, 1874-'77-'78, 6v. 4°.
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GEOLOGICAL

AND

NATURAL HISTORY SURV

OF

MINNESOTA.

THE SIXTH ANNUAL REPORT

FOR THE YEAR 1877.

OFFICERS OF THE SURVEY:

N. H. WINCHELL, State Geologist, - - In Charg
S. F. PECKHAM, - - - - - Chemistr
M. D. RHAME, - - - - - Topograph
P. L. HATCH, - - - - - - Ornitholog
ALLEN WHITMAN, - - - - Entomolog
CLARENCE L. HERRICK, - - Laboratory Assistan

Submitted to the President of the University, May 25, 18

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1878.

THE BOARD OF REGENTS OF THE UNIVERSITY.

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ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1877.

To the President of the University :

DEAR SIR—I have the honor to offer, and to transmit through you to the Board of Regents of the State University, the Annual Report required by law on the progress of Geological and Natural History Survey of the State, being the sixth since the beginning of the survey.

Very respectfully, your obedient servant,

E PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey. 34 pp., 1860. Reprint from the Wisconsin Reports for 1858. Out of print.

Statistics and History of the Production of Iron, by A. S. Hewitt. 47 pp., 1860. Reprint of a paper read before the American Geographical and Statistical Society, January 31, 1856. Out of print.

Report of Anderson and Clark, Commissioners on the Geology of the State. January 25, 1861. 8vo. 26 pp. Out of print.

Report of Hanchett and Clark, November, 1864. 8vo. 82 pp. Out of print.

Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior. 1866. 8vo. 23 pp.

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Report of N. C. D. Taylor on the Copper District of Kettle River, incoporating Mr. James Hall's estimate of the copper prospects of that district. 1866. 2 pp. 8vo. Found only in the Executive Documents.

Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June 17, 1871. 8vo. 16 pp.

The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp., with a colored geological map of the State. Published in the Regents' Report for 1872. Out of print.

The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 148 pp. 8vo.; with illustrations.

The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo., with two county maps. Published in the Regents' Report for 1874.

The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington. 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.

The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with Reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson; 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the

REPORT.

I.

SUMMARY STATEMENT.

The Regents having authorized a joint examination with the State Board of Health of the water supply for domestic uses in the Red River valley, the first work undertaken in the season of 1877 was an attempt to ascertain the cause or causes of the unwholesome water often found in common wells throughout the valley of that river. About four weeks were spent in that part of the State, the observations extending from Breckenridge, the present terminus of the St. Paul & Pacific Railroad, to Winnipeg in Manitoba. The details and the results of this examination will be found in the following pages. It is sufficient here to say that the chief cause of the "stagnant," or foul water so common in wells of that part of the state was found to be the almost universal practice of curbing wells with pine wood; and that there is nothing in the water itself which is unwholesome or injurious. It is true that wells from the drift-clay are apt to be more or less alkaline, unless from extensive gravel or sand beds within the clay, but there is no reason, except artificial or unnatural causes, why the water of that part of the State should become foul or "stagnant" in common wells, any sooner or more frequently than in any other equally clayey portion of the northwest. It was found, indeed, later in the season, that this difficulty is by no means confined to the valley of the Red River of the North. It is encountered with equal frequency throughout the entire western half of the State, from the Iowa line northward to Manitoba, and must be referred to some cause that is not local in its application. In the absence of stone for walling their wells, the

early settlers of the prairies, who have been generally men of little pecuniary means, have resorted to the use of pine plank for curbing them, on account of its availability and cheapness, and to this practice may be attributed by far the greater portion of the difficulty, resulting in many cases of sickness (usually typhoid fever) and many deaths. This fact cannot be too widely published, nor its pernicious effects on the general health and prosperity of the newly settled counties too strongly impressed on the people.

Reconnoissances into different parts of the state have been made during the season, having different objects in view, viz.: one into Wright county for the examination of localities of reputed "coal" outcrop; one into Rice county preparatory to the survey of the county by Prof. L. B. Sperry; one into Goodhue county preparatory to the full examination of that county during the coming season; one over the line of the Northern Pacific railroad supplementary to the water-examinations of the Red River valley earlier in the season, and for geological observations, and one into Morrison county for the purpose of preliminary geological observations. The results of these reconnoissances are given in the following report, so far as they can be made useful at the present stage of the survey.

In the survey of Hennepin county it was found necessary to embrace some parts of Ramsey, and during the past season the survey of that county was completed, and is herewith reported, with the usual maps and diagrams.

Rock and Pipestone counties, the most southwesterly in the State, have also been examined, and are reported in the same manner.

Rice county has also been surveyed in detail by Prof. L. B. Sperry of Northfield College, and his report on the same is herewith transmitted.

Further examination of the fossils of the Trenton was carried on during the intervals of interruption of the field-work, and some further notes on the same are given in the following pages. It cannot be expected, however, that while the field-work is steadily carried on the detailed laboratory work of palaeontology and lithology will progress with equal pace without the employment of extra assistance. Still such progress as is possible will be reported from time to time.

There is, accompanying this, a detailed report on the General Museum for the year 1877, showing the addition of minerals, and specimens of foreign rocks, as well as the naming of fossils in the cases of the Museum. There is work enough now on hand, in the Museum, to require the steady work of a man a whole year, with

nothing else to do. It cannot be impressed to strongly on the Regents that there is a necessity of employing more assistance, or of the curtailment of some of the labor now devolving on a single man. It is certainly very necessary that the Museum be placed in its best condition. This implies the working up of many boxes of material, both in mineralogy and lithology, and in palaeontology. This is nearly all within the purview of the geological survey of the State, the material being almost all the product of the field examinations, and would redound to its substantial progress perhaps to a greater extent than the continued and constant prosecution of the field-work.

The report of Prof. Peckham on the chemical analyses of various substances submitted in the progress of the field-work is also included in the following pages; also, that of Dr. P. L. Hatch on the investigations he has prosecuted during the year on the ornithology of the State.

The year has been signalized by the disappearance from the State, and from the entire Northwest, of the Rocky Mountain Locust. The interesting and important report of Mr. Whitman on the phenomena and causes of such disappearance, and on other insects injurious to farm products still existing within the borders of Minnesota, is also transmitted herewith.

In Botany, while there has been a steady increase of specimens, gathered by Mr. Herrick, or presented by other collectors, there has been no attempt at classification or thorough examination. The progress of the work in this field will be mainly in the gathering of material, for several years; but finally the aid of expert botanists will have to be obtained in the preparation of a final report.

The officers of the Northern Pacific and of the St. Paul & Duluth Railroads very courteously furnished the State Geologist with passes over their roads while engaged in the northern part of the State, and those of the St. Paul & Pacific and of the Red River Transportation Company extended the same favors during the progress of the survey of the Red River water supply.

A considerable portion of the season has been spent in the northern half of the State. What has been done there has been of the nature of hasty reconnoisances. Nothing else is possible. The means now available for the survey will not warrant the commencement of detailed surveys in a region mainly without roads and but sparsely inhabited, however great the need of geological examination. It is mainly for this reason that the survey has been carried on during the past six years in the southern portion, where, at much less expense, the utility of the survey could be demonstrated

and its progress be more evident; as it is well known that geological surveys have, in various states, come to unfortunate interruption, and sometimes final termination, for causes immediately political or economical. The time has come, however, when it will not be prudent nor just to further ignore the northern half of the State. An unusual impetus in immigration, and in prospective mining, has stirred the people in that part of the State, during the past year, to make serious demands for the services of the Geological Survey in exploring and developing their material resources. The enterprise of the government of the Dominion of Canada on our northern frontier, in the building of railroads and canals, will not fail to react powerfully on the State of Minnesota north of Lake Superior. The Canadian geologists have already visited and reported a number of times on the contiguous portions of the British Possessions. It seems to be very necessary to subject that part of the State to a thorough geological survey; but it will require expensive outfits for two or three exploring parties, and it would be several years before the survey could progress sufficiently to warrant a final report. Meantime, during the progress of the work in the northern part of the State, investigations should not be suspended in the southern portion. In order to carry on the survey now as it seems to be necessary, an additional sum of six or eight thousand dollars per annum, for about four years, should be available. It would then be possible, probably, to issue a couple of volumes of a final report, one on the southern palæozoic formations, and one on the metamorphic and azoic rocks of the northern portion of the

II.

THE WATER SUPPLY OF THE RED RIVER VALLEY.

The State law by which the survey is being carried on requires a complete account of the mineral and other waters of the State, including accurate chemical analyses. It was at the instance of the Secretary of the State Board of Health that the immediate examination of this region was undertaken; the sanitary questions involved being regarded of great importance. With a view to the co-operation of the Regents and the State Board of Health in this examination, a joint party was organized, consisting of the State Geologist, with Prof. S. F. Peckham on the part of the Regents, and Dr. C. N. Hewitt, Secretary of the Board of Health. The plan of procedure consisted in a descent of the valley from Breckenridge, on the St. Paul & Pacific Railroad, to Winnipeg, in Manitoba, stopping at the principally settled points for information concerning the objects of the survey, examining all accessible wells and procuring samples of water, and carefully noting the nature of the river bluffs. Subsequently, and during the further prosecution of the field-work over the western portion of the State during the season, more extended observations on the same subject were made by the State Geologist outside of the Red River valley, and the valley itself was again visited for further facts of comparison and verification. The conclusions arrived at in this report are based on all the facts observed; and as they vary somewhat from opinions advanced by other members of the party, it is but just to relieve them from all responsibility for them. Soon after the return of the party a summary of these conclusions was prepared at the instance of Gov. J. S. Pillsbury, and it was published in the *Pioneer Press* for September 18, 1877:

It is also necessary to state that the samples of water selected for analysis were not such as would test the correctness of these conclusions, nor that of any theory that has yet been advanced for the cause of the foul waters of the Red River valley. In order to determine something by chemical analyses of the waters, the writer selected and urged the full analysis of four samples only, with qualitative tests for other samples to show their relations to either of these, viz.:

1. Some simply alkaline water from a deep well.
2. Alkaline water from some deep well contaminated by organic decay.
3. Water from some shallow well uncontaminated by organic decay.
4. Water from a shallow well foul from organic decay.

The analysis of water from the following wells, conforming to the conditions required by the above varieties of water, was recommended for the purpose of arriving at some satisfactory result. It is to be hoped that the survey may be able at some future time to institute further examination, and chemical analysis, should the explanation here given not prove sufficient.

1. Water from the Brewery at Moorhead.
2. Town well at Breckenridge.
3. McHench's cistern well at Fargo.
4. Well at Mr. Sloggy's house (not the Bramble House.)

The Facts Known Before the Survey.

The flat prairie country generally, throughout the western portion of the State, has been much troubled by bad well water. This has been reported to the survey from Lyon, Renville, Redwood and Murray counties, in the southwestern portion of the State, and had by the parties troubled by bad water been attributed to a so-called "peculiar clay," a "blue clay," a "black clay," or to some other deposit in the drift which had been met with in the wells. Similar reports had come from the country further north, and latterly from the Red River valley specially. The settlement of the Red River valley has been rapidly going on during the past two years, and these difficulties were more numerously and urgently presented from that quarter of the State. As these waters had a very deleterious effect on the health of the people, and threatened to retard the development of that portion of the State, the State Board of Health very wisely initiated the systematic examination of the whole question which is now being made, but directed itself specifically to the valley of the Red River of the North. The waters

from the wells dug, whether deep or shallow, have been found to become foul, or "stagnant," sooner or later, and if their use has continued much beyond the discovery of this condition they have produced diarrhœa of a persistent nature, and finally typhoid fever. Some cases have terminated fatally. These facts were of occurrence on the line of the St. Paul & Pacific Railroad, at nearly all the stations west of the line of the Big Woods, even outside the valley of the Red River; on the Northern Pacific Railroad west of Detroit; along the same railroad in Dakota, and down the valley to Winnipeg. These effects were known also south of the Minnesota river, but they have not been attributed so directly, so far as the writer is aware, to the water used for domestic purposes. Yet typhoid fever and intestinal diseases have had, during the past ten or fifteen years, an area of greatest prevalence in western Minnesota and Iowa, according to the ninth United States census. The ascertained relation of cause and effect between bad well water and these diseases in one section of the State, together with the known existence of the same effect in another section under like conditions of soil, climate and surroundings, reasonably leads to the inquiry whether the same cause has not prevailed there also, though it may not have been so distinctly recognized. Another fact that had been stated and well authenticated before the beginning of the survey, was the good quality of the water when the wells were first dug. It has also been stated that during the construction of the railroads that cross that portion of the State, a number of shallow wells were dug in the surface of the prairie, without reaching much water, and that they often became foul in a few days, though wholly uncurbed.

The Wells that were Visited and Examined.

The following facts were gathered by the writer:

Morris.—At Morris, in Stevens county, which is on the Pomme de Terre river, a tributary of the Minnesota, and not within the valley of Red River, the wells are usually bad, and the people generally use the water of the Pomme de Terre. Wells have to be dug rather deep, and through a blue hard-pan. The railroad company are now boring a well having a diameter of sixteen inches. They turn a sort of auger by a single horse-power, and take out the clay as an auger takes out wood, but it has to be lifted out frequently. The material thrown out, now at the depth of 56 feet, is a blue clay with few stones, but some small gravel. No water has been met with yet.

According to Mr. Leonard B. Hodges a well of good water was obtained at Morris later in the season of 1877. It is owned by Judge L. E. Pierce. It is surrounded by foul wells, several of about the same depth, and others of not half that depth. It is in every respect like many other wells at Morris, except in not having wood curbing. It was "driven," *i. e.*, after digging some depth an iron pipe with protected sieving was driven into the clay till water was found which rose in the pipe. This well was good and has remained so.

St. Gabrielle Springs. NE¼ Sec. 17, T. 130, 45.—Three miles from Campbell station, a little south of east. Here are St. Gabrielle Springs, said to furnish "good water:" but although there is a scummy deposit of iron running from them the water tastes alkaline, and is very much like the water of the deep well at the station. There is a boggy area of about two and a half acres lying a few feet above the water of the stream (Rabbit river) from which the water of the springs runs into the creek. This area is in a bend of the stream, and lies about six feet below the general level of the prairie. The stream is about twelve feet below the prairie and empties in Bois des Sioux river. It is a small stream and has clear water, but an imperceptible current. In some of the springs which are scattered over the boggy area mentioned, there is a light colored sand seen boiling up with the water, and in the sand are also some weathered small shells. The bog itself is peaty, and shows some small fresh-water shells. The banks of the stream show nothing but the usual gray drift-clay, containing boulders of granite and many pieces of limestone. The water of the creek tastes swampy and flat. The stones and the gravel of the drift, along the low bluffs of the creek, are mainly of limerock—perhaps three-fourths of them, the rest being granite, &c.

Over the surface of the prairie about, which is nearly flat, are occasional fragments of limestone, which are usually somewhat imbedded in the surface, showing the *glacier origin* of even the latest part of this flat. There is no loam here, nor stratified fine clay. There is only a gravelly or stony clay that is blackened at the surface. On making a few qualitative tests on the spot on the water of this spring, for comparison with that of the water at Campbell Station coming from the deep well there (next mentioned), it was found to agree, even by actual comparison in hand, almost exactly with the water of that well. They both possess abundant sulphates, carbonates strong, and plenty of chlorides. The only perceptible difference in mineral constituents was a little greater quantity

of iron in the well water. On making quantitative examinations Prof. Peckham reports these waters to contain impurities as follows:

	Total mineral matter.	Organic and Volatile.	Total residue at 30° C.	Removeable Hardness.	Permanent Hardness.	Total Hardness.	Chlorine.	Suphuric Acid.	Lime.	REMARKS.
2.	62.458	12.316	74.764	10.216	15.468	25.684	10.623	4.202	6.647	These waters show a very remarkable similarity of mineral constituents.
3.	55.454	12.481	68.295	8.756	11.960	20.722	No Estimate	5.370	6.864	

As the water at the station is foul and unfit for use, while that from these springs is pronounced good, and even has a reputed excellence, both waters coming through the same natural drift deposit, subject to the same natural causes so far as their source is concerned, while the spring water itself is free from noxious odors, it is evident the difference of the waters cannot be indicated by chemical analyses of the mineral constituents. It is also evident that the difference, whatever its nature or origin, must be superinduced by some *artificial*, and not natural, cause; in other words, that there is something inherent in the well, or its artificial surroundings, that superinduces the noxious odors. The trouble, further, cannot lie in the clay of the drift, since the spring water is constantly in contact with the clay, and the well water is brought up through an iron pipe which is said to run to the bottom.

Campbell Station.—The well at Campbell Station was sunk several years ago by C. E. Whelpley, of Minneapolis. The following section of this well was furnished by him July 19, 1875:

1. Hard yellow clay with strong bitter water.................... 18 feet.
2. Blue clay.. 53 feet.
3. Boulders, or rock of some sort.............................. 4 feet.
4. Blue clay.. 39 feet.
5. Blue clay, boulder, gravel and flint......................... 11 feet.
6. Sand, gravel and clay, with some coal........................ 21 feet.
7. Sand, gravel, blue clay, slate, some coal.................... 4 feet.
8. Hard blue clay.. 15 feet.
9. Clean sand with water, mixed with coal (10 per cent.)..... 8 feet.
   [NOTE—This coal on examination was found to be drift pieces of Cretaceous lignite—N. H. W.]
10. Stony blue clay, but softer below, with more water at the bottom.. 87 feet.

Total depth................................ 260 feet.

The lower portion of the pipe becoming filled with mud it was found necessary to puncture the pipe at higher levels and admit water above the clay filling. This was done at 176 feet. The water rose within four feet of the surface.

At the depth of 173 feet found wood which was covered with yellow substance like gold (probable pyrite—N. H. W.) and was heavier than water. Water was obtained at 125 feet, and again at 150 feet, also at 165 feet.

The water pumped out of this well in June, 1877, was turbid with sediment and visible floating particles, and had foul odors. It could not obtain these foul odors from the bottom of the well, nor furnish these floating particles from that depth, since they were evidently both of organic nature. The upper ten or fifteen feet of this well were dug larger than the rest and curbed up with pine boards after the manner of most wells on the prairie.* This was partially filled with water and served as a reservoir. This water must certainly find access within the iron pipe, either through intentional rupturing of the pipe, or loose fitting of the pipe upon the lower joint of the pump. It otherwise passes along the outside of the pipe, between the pipe and the surrounding clay, to the bottom of the well, and is drawn into the pipe at the bottom. This last supposition is hardly possible, as the closeness of the clay about the pipe is probably as perfect as about any stone or boulder, and must be as impervious. Further the surface water would not thus naturally flow downward, being warmer and lighter, as well as being under less hydrostatic pressure, as long as there remained a supply for the pump within the pipe.

About a mile northwest of Herman the railroad passes down a terrace to a lower flat, the change of level being about fifteen feet. Hence the well at Campbell Station, wholly dug in the glacier drift, without any overlying stratified clays, cannot be affected by any lacustrine clay that seems to have been deposited over large areas in other parts of the Red River valley. The glacier drift itself, over wide tracts in this valley, lies at the very surface.

At Breckinridge.—At this place, which is near the junnction of the Otter Tail and Bois des Sioux rivers, the grade of the railroad is just twenty feet lower than at Campbell Station, and a hundred and six feet lower than at Herman Station. The distance from Breckenridge to Campbell Sta-

*On inquiry of Mr. Whelpley concerning this well he affirms that no wooden curbing was used in the shallow preliminary digging, the only design being to get room to enter his pipes, and that the dug part was almost entirely refilled, leaving but a shallow basin round the pipe at the surface.

tion is fifteen miles, and from Breckenridge to Herman is thirty-nine miles; the country in all directions being a smooth prairie for many miles, with no visible changes except at the terrace mentioned, near Herman. Yet at Breckenridge, along the river banks, are broken areas of true lacustrine clay. This runs back from the river and covers a small indefinite area. It seems to have been deposited on a slightly uneven upper suface of glacier clay, or unmodified drift, so that it here only occupies the depressions in the glacier clay.

The town has five wells, but only one is used. It is the hotel well, owned by Mr. Sanders, who described it as follows. It is curbed with boards.

Sanders' Well at Breckenridge.

1. Mucky, black soil, no stones .... 2½ feet.
2. Fine clay, without stones; the same as seen in the river banks .... 16 feet.
3. Gravel—small pieces of limestone, and granite boulders, with some layers of clean sand .... 10–12 feet.
4. Under the last, which furnished water, was an unknown thickness of a black or blue-black clay, that had a different odor. This contained stones and boulders, one of which stopped the further sinking of the well, which, however, did not penetrate it to any considerable depth.

The water of this well, analyzed by Prof. Peckham, shows the following composition, as reported by the Secretary of the State Board of Health:

	Grains per Gallon.
Total solid matter in solution	86.024
Total organic matter in solution	12.286
Total mineral matter in solution	73.756
Total hardness	19.843 $CaCO_3$
Permanent hardness	8.756
Removable hardness	11.387
Sulphuric acid in solution	1.868
Chlorine	17.395

These results show a general resemblance to those of the well at Campbell Station, and the water of St. Gabrielle Springs, containing nearly the same per cent. of the various mineral peculiarities.

The town well was mainly a bored well, but is curbed with pine boards. The water here varies. Sometimes it has been pretty good, especially at the first, but at the time of this examination it was strongly charged with sulphuretted hydrogen. It is in the

street, and near no sewers. The ground was raised about the mouth of the well to prevent in-drainage from the surface.

Town Well at Breckenridge.

1. Soil and clay. .... 4 feet.
2. "Black clay," &c., with gravel stones, no water........... 30 feet.
3. Gravel and sand, with water in abundance, that rose 16 feet in a few minutes.........................Thickness unknown.

On analysis this was found to be a very hard mineral water, containing large percentages of sulphates of lime and magnesia, but "on evaporation had the appearance and odor of urine residue." This water may be taken as a type of the waters derivable from deep wells that penetrate the glacer drift-clay, when not materially changed by contact with organic acids.

The well of Peter Hanson was dug entirely, 3½ feet square, and curbed with pine boards. The material thrown out is unmodified drift-clay, of a dark-blue color, containing stones and boulders, some ten and fourteen inches in diameter, which show smoothly polished and also striated surfaces. The clay itself is nearly black when wet, and is charged with little stones. This well did not pass through the drift clay, and now affords only "seep water," which, after a month or two, will about half fill the well. It then has a foul odor which is attributed to the "black stuff," as the drift-clay is designated.

Peter Hanson's Well at Breckenridge.

1. Clay, as in the river banks; fine and horizontally stratified..4–5 feet.
2. Drift clay, dark colored, hard and strong, no water, penetrated............. .... 50 feet.

The well of Chas. B. Falley, Esq., is altogether in the lacustrine clay. It afforded pretty good water at first, but in a few days it became offensive.

C. B. Falley's Well at Breckenridge.

1. Black loam soil......................................4 or 5 feet.
2. Light colored clay, with some sand, without stones, crumbling in the air........ .... 24 feet.
3. Sand with water (17 feet of water)...........Thickness unknown.

From Breckenridge the river was followed in a small row-boat to McCauleyville, opposite Fort Abercrombie, for the purpose of carefully examining the banks.

Section 21, Town 133, Range 47, Wilkin County.—Mr. Edward Connelly has here a well twenty-five feet deep, in which the water rises and falls as the river changes, indicating an intimate connection. The well is near the brink of the bank, which rises about twenty-two feet above the river. The bank is made up of about eleven feet of gravelly and stony drift clay, without any overlying lacustrine clay, underlain by a heavy bed of gravel and sand exposed along the bank a short distance above his house. Mr. Connelly also described his well as penetrating these materials only. In this gravel are pieces of Cretaceous lignite and slate. The presence of this gravel bed, and the rising and falling of the water of the well coincident with that of the river, proves a close relation between the two, but not a flow necessarily from the river to the well. There is not much doubt that the gravel bed is itself a vast water-reservoir, which is being filled by inflow from higher levels, and is slowly drained toward the river by hydrostatic pressure. The analysis of this water rather goes to show this to be the direction of flow, since there is much more mineral matter in the well than in the river water, a change that could not be produced by simply filtering through gravel for a few feet.

Descending the river below Connelly's, the light-colored, lacustrine clay, mentioned at Breckenridge, is seen to become more and more developed. and at last continuous, with a thickness of 25 or 30 feet, equal to the hight of the entire banks above the river, with only occasional exposures of the hard-pan clay near the river level. The hardpan finally disappears about two and one-half miles above McCauleyville, near "Aker's place," the last exposure being near the rope ferry. Below this place the lacustrine clay constitutes the entire bluff of the river. Before reaching this place the large boulders, which appeared frequently in the river for some miles below Breckenridge, had entirely disappeared. At the same time timber along the river becomes more and more abundant, and also larger. At first it consisted almost entirely of willows and box-elders, but as this change comes on large trees of white and burr-oak, ash, elm, bass and hackberry make their appearance. The bottom lands widen out, and at the same time become higher, reaching 15 feet above the water, while the lacustrine clay bank, outside of the bottom land, rises about 15 feet still higher. This lacustrine clay covers the country generally, east and west, especially up the tributary valleys; and it is plain to be seen that it will

constitute a different agricultural land from the alkaline plain further south, based on the drift-clay.

There are here then these three formations, all pertaining to the drift:

1. Latest of all, *the alluvium* of the present river, which is mainly sandy, and supports the timber. It is without stratification generally, and swallows burrow in it. Its thickness varies with the hight of the freshet stage of the river, becoming greater toward the north.

2. The *lacustrine clay*, which covers the higher flats, and constitutes the soil of the valley over much of this region. It is of a light and loamy color, horizontally stratified, and is without stones or gravel. This is the sediment of the lake which was drained by the Minnesota river southward during the prevalence of the last ice-period, or on its partial withdrawal.

3. *The blue hardpan clay*—The immediate product of the great glacier, containing gravel stones and striated boulders. This fills the whole valley, running under the lacustrine clay and rising so as to constitute the surface of the country a few miles east or west of the river, becoming rolling, and even hilly, in the Leaf Hills and Coteau de Prairie, but lying smooth and level in the valley. This may have been originally deposited nearly level and smooth, as it now lies, owing to the presence and agency of much standing water, or it may have been somewhat smoothed off at a later date by the lake that covered it. This whole region, then, and especially the general aspect of the flats at Breckenridge, are a fac simile of the Maumee river and the "Black Swamp" region of northwestern Ohio, minus the timber and plus the alkali of the drift clay. Its origin was the same, and probably also its date, both pertaining to the period of the last glacial epoch. The theory advanced some years ago for the manner of deposit of this glacial drift*, here is confirmed by being equally applicable. It was received in these valleys, in a lake of water direct from the ice, and was let down gently without much modification, and stratification as fast as the ice sheet contracted; the horizontally laminated clay, in both places being the result of such lateral distribution of the clayey portions as the lake could effect, and of such later lacustrine deposit as water is apt to form, during its continuance as a lake. Further to

*Proceedings of the American Association for the Advancement of Science, 1872—*The Surface Geology of Northwestern Ohio.* Also the Popular Science Monthly for June and July, 1873—*The Drift Deposits of the Northwest.*

the north it covered the surface of the glacier, but by degrees became embraced further still north, in its general mass, and extended even to the bottom of the ice. It became superficial near the margin of the glacier by the thawing and wastage of the upper surface of the ice.

McCauleyville—James Nolan's well, 32 feet deep, affords a strongly alkaline water. It is situated on an irregularly ascending slope from the river toward the general level, and six feet below the general level. It was bored 17 inches in diameter.

Nolan's Well at McCauleyville.

1. Soil and black loam	2½	feet.
2. Brownish-yellow clay, with no noticeable stratification, nor gravel, nor stones	26	feet.
3. "Black sand," quicksand	4	feet.
4. Gravel, shells, and rounded stones, like the bottom of a lake, with water, went into it	1	foot.

This well seems to have got water in a layer of sand and gravel lying between the lacustrine clay and the hardpan clay, but on analysis it is proved to be heavily charged witn alkaline ingredients.

Langerin's Well at McCauleyville.

1. Loam and soil, and light clay	15	feet.
2. Blue, gravelly clay, with boulders, containing one layer of sand and gravel of 3 feet thickness, at the depth of 40 feet. No water of any amount was found in this well, and it was refilled. This blue clay had pieces of coal and Cretaceous slate, and granite boulders. The sand layer gave offensive water. At about 100 feet there was a layer of about 6 feet of very fine blue clay which makes a good polishing material	122	feet.

It is possible, if not probable, that in the foregoing the lacustrine clay assumed a blue color after passing 15 feet, and thus really extends to the layer of sand and gravel mentioned at the depth of about 40 feet, and which is said to have given offensive water. The absence of gravel and stones in the upper part of the "blue clay" was not, in that case, carefully noticed, and the color being the same would very naturally cause it to be set off with the great mass of stony blue clay lying below it. This hypothesis is all the more likely, as the offensive water from the sandy layer may then

lue to the vegetation and muck that would have accumulated in bottom of the lake which immediately followed the deposition he stony blue clay—a lake bottom which is also indicated by Nolan's well at about the same depth below the general level.

n digging Mr. David McCauley's cellar a large deposit of bivalve h-water shells was encountered. Other shells were found in ging the cellar of Mr. Longevin. These cellars are far above river, and yet not so high as the general level of the country. ese shells of course belong to the period of the lacustrine clay, ier during or following the last glacial epoch.

'here are said to be two terraces east of McCauleyville. One is r miles east, and consists of gravel, and one is thirteen miles ; and consists of sand. There is a depression, or longitudinal in, running north and south, between these terraces, in which er stands some years all summer.

t and below Fort Abercrombie are large and numerous selenite stals. They were found by Mr. Nolan about three miles below fort, in the slope of the bank of the river, and by the soldiers r the fort in digging a well. They are said to have occurred, in well, above a heavy deposit of boulders: hence seem to be in drift, and not in the Cretaceous.

Moorhead—In riding over the prairie from McCauleyville to Moor-d, a distance of about 30 miles, sometimes several miles east of river, only seventeen granite boulders were seen on the surface. ese were from six to twelve inches in diameter, and were entirely tary, being generally half buried in the soil. There was seen gravelly clay, nor small stones in clusters, nor any alkaline ting, all indicative of the drift clay, throughout the whole ride, ; only a fine clay loam.

The well of C. P. Sloggy, at the Bramble House, is 22 feet deep, l wholly in the lacustrine clay, having struck at that depth a cksand three or four feet thick, giving water. This well was ently dug (in May) and the water is tolerable, though evidently aline, and having a taste of the pine curbing. It is, however, s alkaline than water from the hardpan clay. It is said that re is a layer of sand all over this country, including Moorhead l Fargo, at about 22 feet, in which the same water can be got.

The well dug by Sharp and Douglas, situated in the public park, across the street south from the last, and has the same depth. It w tastes (June 23, 1877,) as if kerosene had been poured into it. It

was dug about a year ago. The kerosense taste is owing to the decay and discharge of the pitch of the pine curbing, and will probably pass off.

Mr. Sloggy has another well dug to this layer of sand about a year ago, about two blocks further south, situated in the street, in an unfrequented part, which at first had a flow of good water, but finally became bad and had to be abandoned. On examination this was found to have the odor of decaying organic matter, and even of animal matter. It has been in disuse and shut for some months, the tight pine curb rising about 20 inches above the ground and covered with a board nailed over it. Hence the contamination cannot come from dead frogs nor rats, nor yet from sewage nor from surface indraining. Like most of the wells in the town the surface of the ground is elevated about the well, by throwing back round the curb the clay excavated in digging.

At John Erickson's Brewery is a well 105 feet deep, dug about two months ago (April or May, 1877). This well is used at the rate of 15 or 20 barrels per day. It is curbed with pine.

The Brewery Well at Moorhead.

1. Light clay	20 feet.
2. Quicksand	4 feet.
3. Blue clay with gravel and boulders	80 feet.
4. Sand, with copious water	

The water from the bottom of this well was under such hydrostatic pressure that it lifted up bodily "about two feet" of the entire clay bottom of the well, and rose immediately about 80 feet in the well. The water is strongly alkaline, but bright and clear, and is used for beer-making in preference to that of the river. This well was too recently dug, and is too copiously used, to show any markedly bad effect from the pine curbing.

The well of Lamb Bros. is sixteen feet deep, situated under the floor of a livery barn. It is curbed with pine. The water has an alkaline taste, which is said to be "sweet," and is very copiously used. It has never been noticed to be offensive, but will not do for washing. The clay here was but six feet thick, and the sand is said to have been ten.

Jacob Thomas' well is 14 feet deep, curbed with pine, smells and tastes of decaying organic matter, but not strongly of alkali.

Fargo—The well at the Fargo House is 25 feet deep, and the water is now good—as good as any water. It was dug one year ago, and is curbed with pine. Probably the fermentation took place last season. Indeed, a gentlemen who was at the house at Christmas affirms it was not so good then as now; yet the landlady, who probably would not notice a gradual change in the water, says it has always been as now; although she also admits it did "taste of the pine and was cleaned out." Another gentleman says it was not used for a time.

The well of J. C. Winslow is 25 feet deep, lately dug and just furnished with a pump. It is a good water also, as good as any hard water. The well is curbed with pine. For a time it was unfit for use.

At the Sherman House is a shallow well, dug four feet square, curbed with pine, has plenty of water which rises about ten feet, and is absolutely horrid with effete vegetable matter. It was dug last year, but has been in disuse for some time.

The well at the livery barn of A. H. Moore is a shallow well. It is curbed with oaken barrels and furnishes pretty good water, but has a pine pump running below the curbing. The water gives off a little sulphuretted hydrogen, but much less than the well at Mr. Moore's house.

The well at Mr. Moore's house is 96 feet deep, curbed with pine. It is an alkaline water, and has a strong odor of sulphuretted hydrogen.

Mr. McHench's well was dug for a cistern and is about 12 feet in depth. It is bricked up and cemented. The water broke in at the bottom and has always been good.

Mr. Roberts' well, near Fargo, is a shallow well, and smells very bad, but was very good at first. It has a pine curb.

A number of other wells were examined at Moorhead and Fargo, but the facts were only a repetition of the foregoing. They were all shallow wells, curbed with pine, had good water at first, and after a few weeks or months became foul and had to be abandoned.

The lacustrine clay is thinner on the Moorhead side than on the west side of the river, and wholly disappears a few miles east of Moorhead, the alkali of the hardpan clay appearing in low exsiccated spots. This occurrs before reaching the south branch of Buffalo river.

On visiting Moorhead again later in the season (September 1877) some of the wells that were unfit for use in June were found somewhat improved, especially those that had been copiously pumped. The Bramble House well was not improved, but rather had become worse. Mr. Sloggy referred to the well of Mr. Mangus Peterson as a curious illustration of the fickleness of the water in the Moorhead wells. This is situated only across the street from his at his house, dug about the same depth (26 or 27 feet) and is curbed like his with pine, but affords the "best water in the town." This seemed to imply that the fault is not in the curbing. On examination of this well it was found, as stated, to afford as good water as Mr. McHench's in Fargo, and was dug in September, 1876. It had been so foul that it was not used for several months. This summer it was emptied repeatedly and began to improve. The neighbors also began to use it, so that it soon acquired a reputation for its excellence. In this case the copious use of the well is what renders the organic impurities imperceptible. By standing it will probably relapse into as bad a condition as before.

Glyndon—At Glyndon the wells are all alkaline, and also generally about sixteen or twenty feet deep. They pass at once into the hard-pan clay. They are all curbed with pine. Only one is now fit for use. It is that of the house lately purchased of Major Tenny by James McLenan for use as a hotel. This does not taste of organic decay, but is strongly alkaline. The well at the present McLenan House is very foul, but the former is freely used by the whole village. The well at the Campbell House is not used. It is very heavily charged with organic decay in its foulest stage, and has been in disuse much of the time for four years. Though cleaned out about a year ago, and used slightly for a few months, it is still unfit for use. It is within a few rods of the above named well which is used by most of the families of the village, and has about the same depth. Water from the well in general use was examined chemically by Prof. Peckham, and compared with a similar examination of that from the Campbell House, without showing any important difference in the impurities contained in solution. They are both hard waters. While from one is escaping constantly a volume of noxious organic odors, including sulphuretted hydrogen gas, the other is wholly inodorous, and is freely used for all domestic purposes. It is plain that there is something in the surroundings of the wells which causes the difference. They are both curbed with pine and were dug some years ago. It is also probable that the

copious use of the one keeps it substantially inocuous, while the disuse of the other intensifies the foul qualities. That in constant use is a large open well. That which is foul may be confined and covered. It is also evident that the bad qualities of these wells cannot be detected by the ordinary chemical examination of their mineral impurities. In other words, the foul odors arise from organic ingredients which are volatile. There is no other supposable cause for these odors adequate to the explanation of so prevalent a disorder, than to attribute them to the decaying pine curbing which is co-extensive with the disorder.

There are several other wells at Glyndon, but they are all bad from the same cause. They are sunk in gravelly clay, and get water in gravel.

The well at the Round House, situated somewhat west of the village, was dug in 1872 by the St. Paul & Pacific Railroad, and is reported as follows by Chas. A. F. Morris, who was Chief Engineer when the well was dug:

Round House Well at Glyndon.

1. Black soil	1 ft. 3 in.
2. Yellow quicksand	12 ft.
3. Blue quicksand, sheets of turf and vegetable deposits	3 ft. 6 in.
4. Blue clay and drift wood	2 ft.
5. Blue clay	2 ft. 7 in.
Total depth	21 ft. 6 in.

This section is interesting, as it reveals a layer of drift wood 18 feet below the surface. While this was probably deposited by the current of Buffalo river, which runs near Glyndon, during some earlier history of its channel, which then must have occupied a different position from what it does now, it may still be due to water-logged drift wood that was gathered along the shore of the ancient lake that once extended to or even beyond Glyndon. The character of the material overlying the drift wood ("yellow quicksand") strongly indicates the fluvial rather than the lacustrine origin of the drift wood. Its not having been discovered at other points is cumulative evidence of its not extending generally under the country about Glyndon, as it would be more likely to do if of lacustrine origin. Hence it is not likely that the bad odors of the wells there are attributable to vegetable decay from that source. If it were demonstrated or admitted that vegetable decay is the cause of

these odors, it would be folly to overlook the chief known source of such contamination (the pine curbing) and search for it in the soil or clay, or buried drift wood.

At Fisher's Landing, just below Crookston, on Red Lake river, the grade of the railroad is made of gravel, rounded by water action, similar to that seen in a number of places along the road between Glyndon and Crookston, where wave-action has carried away the clay from the drift, and has left the gravel stones strewn over considerable areas. A double handfull of these pebbles, from one-half to one inch in diameter, picked up without selection, afforded seventeen of fine, compact limestone, and four of metamorphic rock. This shows probably an average proportion of limestone pebbles to metamorphic in the drift of the Red River valley in general; though it is probable the limestone pieces would be more numerous still further north, and less abundant toward the south. These limestone pieces are strewn with the drift all over the western portion of the State, even to the Iowa state line, large pieces sometimes being found in the southern tier of counties. They come from the Winnipeg limestone.

Winnipeg—By the courtesy of the officers of the Red River Transportation Company the party were taken to Winnipeg and there made further examinations.

Connell and Burke's well, dug about a month, is 56 feet deep. The water was at first good, but now has a faint taste of sulphuretted hydrogen. This may be attributed to the wood curbing placed in the well, which is of spruce. The well went through 40 feet of fine brick clay, and 16 feet of stony clay, with boulders of granite and limestone.

Wm. Hespeler's well on a lower terrace level, dug three years ago, was used last year by two water-carts in distributing water throughout the city, and was good, but now it is little used, and has a sulphuretted taste. It passed twelve feet through brick-clay and obtained water in quicksand; has pine curbing.

Wm. Hespeler's old well, on the same level, dug four years ago near the last, formerly had a sulphur taste, but now furnishes a beautiful cold water. It is also twelve feet deep. It has a pine curbing.

Thos. Maxwell's well is near the last two; was dug this spring, and furnishes perfectly good water. It is the same as the last two in all essential particulars, except that it is copiously used by three water carts in delivering water in the city. Its depth is also a lit-

tle greater, but the water is from quicksand. The overlying cl: was found to be, as in those, about 12 feet. No stony clay was m with in these wells.

The Messrs. Chambers Brothers have just completed a well, ar put in wooden curbing. It is on the upper flat and 57 feet dee much of the depth being in a stony clay. The water is alkalin and as yet has no taste of sulphuretted hydrogen, or organic odo

The well at the Union Hotel is "sweetly alkaline." It is ju dug, has a wooden curbing, and is 57 feet deep; in gravelly clay.

The well at the Free Press building was dug four years ago, ar is 59 feet deep. The water is alkaline and sulphuretted. The we is curbed with pine, which still affects the water. The water ris from a gravelly clay deposit near the bottom, and stands within te or twelve feet of the surface. It is not much used.

[NOTE—The first well of Mr. Hespeler, mentioned above, is at the Oril House. It is near a barn, with a manure pile very near. It was foul, and being cleaned two or three dead gophers were taken from it. His second well at his brick block, but not more than forty feet from the first. It was also fo and "stagnant" last year, but on being more pumped became good again. T Maxwell well is between them and in a low barnyard or muddy spot. It is us by three water carts. The tight clay of which the surface consists seems to sh all surface impurities whenever the slope is away from the well. This is sho by the Maxwell well which, though favorably situated for surface indrainage, perfectly free from these bad odors, and is largely used.]

The lime rock at Andrew's Rapids, twelve miles below the city Winnipeg, is quarried and used for all building, and even as dress cut-stone for large ornamental fronts. That at Rocky Hill, Stony Mountain, where the penitentiary is built, 17 miles nort west of the city, seems to be of the same general age and textu but is more fossiliferous and irregular. Its color is a light buff, faded drab. It is in all respects, exactly like the boulders a gravel strewn so abundantly over western Minnesota.

At this place the lacustrine clay makes a cream-colored bric Below it, or in it, is a sand layer, which does not seem to be ever where met, which gives good water not perceptibly alkaline. T drift-clay below gives a strongly alkaline water. There are son artesian wells in this neighborhood which rise from below the bl drift-clay, or hardpan.

White Earth.—Mr. G. A. Morrison, of the White Earth Indi Reservation is authority for the statement that the same difficul with bad water is encountered there. The wells are dug in the dr

clay, and are all curbed with pine, with one exception. That also was at first, but the curb was taken out and stone walling was put in. The water was bad before the change, but now it is good.

Detroit.—Wells at Detroit enter gravel within twenty-five or thirty feet, and find a good lining and chalybeate water in abundance. Wells are curbed with pine. The country here is rolling, and the drift clay is very gravelly; indeed the gravel which furnishes the water of wells seems to rise to the very surface. No trouble with foul water.

Perham.—Here the soil is a loam, and the subsoil and drift are gravelly, allowing free underground drainage. Water is found at 20 and 30 feet. Some pine curbs have been used, but there has been no trouble with foul water. The supply is copious.

Brainerd.—Many of the wells curbed with pine at this place are foul in the same manner as at Fargo, Breckenridge, &c. Attention was directed to the fact by Dr. J. C. Rosser, of Brainerd, in connection with the occurrence of numerous cases of typhoid fever which had been attributed to the use of bad well-water. The soil here is sandy, with some clay, with a clayey sub-soil. In company with Dr. Rosser and Dr. V. C. Smith, of Duluth, the writer visited and examined about twenty wells. They were found to be all curbed or walled with pine. They have an average depth of thirty-five to forty feet and penetrate a stony clay deposit. They have mostly been dug for a number of years. The majority have a distinct taste of decayed wood, and are turbid with floating particles from the pine. The smell is not so rank as in many in the Red River Valley, and in most of them no offensive odor can be distinguished, though to the taste there is a distinct trace of organic decomposition. They seem to have a great deal of detached floating (or suspended) fungus growth, which is of a yellowish-brown color and inodorous. These wells are in what might be styled the second stage, or one of fungus growth and dead wood, which is a natural sequence of the rank and odorous stage which they first pass through. The occurrence of frequent cases of typhoid fever both at this place and in the Red River Valley, taken in connection with bad well-water in both places, was suggestive of the possible existence of a common cause. It was for this reason that Dr. Rosser desired an examination of the Brainerd wells. Three samples were procured for chemical examination. They were examined by Prof. Peckham with the following results :

Analysis of Well Waters from Brainerd.

No. 49, above, was from a well used by a family in which there had been a recent case of typhoid fever. The water had been condemned some time before, and the well cleaned with the discovery of several dead mice; but since the cleaning the water had not been noticed to be bad again. The fever occurred after the use of the well subsequent to its being cleaned. At the time the sample was taken the well had been standing again unused, from the removal of the family, for a few weeks. It has a pine curbing. On visiting this well it was found to be perceptibly contaminated with organic decay, which was perceivable by the smell as well as by the taste.

No. 50 was from a well that was not known to have any bad taste or to have been accompanied, in its use, by any cases of fever though curbed with pine.

No. 51, at the Leland House, there had been several cases of typhoid fever during the summer. Indeed, with the single exception of the case in the family of Mr. Alsop, all the cases in the town, (season of 1877) were confined to this house. The water from this well which is in the kitchen and not well protected from surface in-drainage, has a distinct odor and taste very much the same as those in the Red river valley, though less rank. This well is curbed with pine.

These analyses give abundant evidence of organic matters in these wells. The albuminoid and free ammonia can have no other plausible explanation ; but although at the present time their use is visited with typhoid fever, they are no worse than many others which were examined, and probably no worse than most of the wells of the place that are so curbed, during some former portion of their history. In former years this town has been severely afflicted with typhoid fever. At one house, formerly use as a hotel, it had been so common that the house was for some months a very

hospital of typhoid fever, but now is not so much troubled. This well, however, is still bad from the same cause, but has passed its foulest stage. In other cases when these wells have been unused for some time, the odor becomes intensified; and it is a singular fact that familiarity with and use of the water renders it impossible to distinguish it, and even makes it agreeable. The most of the wells examined were said to have "good water" by the owners. Occasionally a man is found who says his well "tastes of the wood;" and also one occasionally who really knows that the water becomes foul from the pine, and recommends instead that *oak* be used.

In Mr. Follet's well, near Mr. Alsop's, the decay is just begun, the well having been dug this summer. It shows in iridescent films that float on the surface of a cupful, but does not now taste very bad.

Herman.—The deep well at this place was drilled by C. E. Whelpley, of Minneapolis, and the following record of it was furnished by him:

1. Blue clay	124 feet.
2. Rock	65 feet.
Whole depth	189 feet.

Water from the top of the rock rose to within six feet of the surface. There was considerable coal on the surface of the rock. The rock was very hard to drill and showed several changes within the sixty-five feet. The following letter may here be given pertaining to this well.

MINNEAPOLIS, MINN., 23d March, 1878.

C. E. Whelply, 1506 3½ Street South:

DEAR SIR:—I have just received your letter of March 22d, written at Herman, containing samples of rock taken from near the bottom of the well you are drilling there; in which you ask me what kinds of rock they are, and the probability of getting a flowing well by drilling deeper. The samples are as follows, as you numbered them, in descending order.

No. 1. "Found 124 feet under blue clay, seven or eight feet thick." This is the same stone as the limestone boulders that lie strewn over the surface of the Red River flats from Winnipeg to Big Stone Lake and beyond, and is found outcropping at the surface beyond the limits of Minnesota in Manitoba. It is a fine grained, buff, magnesian limestone, of the Silurian or Devonian age. Your let-

ter seems to convey the idea that this lies in a layer seven or eight feet thick i mediately over the rock of the next number. That would be anomalous and i expected. It is very probable that this fragment is from a drift boulder, a that the thickness of seven or eight feet was occupied with a compacted bould mass, mostly made up of such rock. It is true that nearly all the boulders a gravel of the drift in that whole region are of this rock, and, according to a w known fact, boulders are much more frequent in the lowest ten feet of the d than in any other part. * * * * * * * *

No. 2. This is a quartzose, granite, parti-colored by flesh-red feldspar. It but a small piece, but is compact and fresh. It has but little mica.

No. 3. This is a white, micaceous quartzyte, in which there seems to be a li gray labradorite.

No. 4. This is a fragment of crystalline feldspar, with one rectangular cle age, and a dull, vitreous luster,—an orthoclase.

No. 5. This fragment consists of glassy quartz and mica.

No. 6. Mica schist, with associated talcose rock.

No. 7. Mica schist with veinings of calcite.

No. 8. Mica schist, changed in color by heat applied since it was taken out the well. (Same as No. 6.)

No. 9. Coarse mica schist. This came from a depth of 186 feet, and is said have begun at 180 feet.

A glance at these samples is sufficient to show that your well is now in metamorphic rock, the strata of which are discordant and highly tilted, and fr which there are no instances of artesian overflows that I have ever heard of. our artesian wells are in higher geological horizons. I should unhesitating discourage you from drilling any deeper in hope of getting a flowing well. Th rocks are several thousand feet in thickness, and are followed by granites a syenites, in which there is no better chance of artesian water.

Very respectfully,

N. H. WINCHELL.

The Surface Geology of the Country.

It is not possible to give a full account of the surface deposits the valley of the Red River of the North. This sketch will confined to such general views as may be gathered from a has reconnoisance, based on such facts as an inspection of the banks the river at numerous points and the examination of the foregoi wells have afforded. The full details will have to be filled in subsequent and more elaborate exploration.

It is found that the lowest portion of the drift consists of a sto clay, which below contains more abundant gravel, and througho many stones and boulders. It is also probable that many we which have been supposed to have passed through it, have o struck water-bearing courses of gravel or sand in the clay its This deposit is generally blue. When it is at the surface it

lighter colored. The stones which it contains are from various formations, but about 75 per cent. of them seem to belong to the Winnepeg limestones. The rest of the stones are granitic. This clay also contains Cretaceous debris, such as slate and lignite. Such lignite sometimes is rather plentiful, and indicates that the Cretaceous formation, which is rather fragile and incapable of enduring long transportation, underlies large portions of the valley, if not the whole of it, and that the clayey portions of the stony clay have been very largely derived from the disintegration of this formation. This is further evinced by the occurrence of crystals of selenite in the drift deposits near Fort Abercrombie, the sulphate of lime being one of the alkaline salts that seems to have been abundantly in solution in the waters of the Cretaceous ocean. This vast clayey deposit of unmodified drift rises to the surface round the margins of the valley and spreads out in extensive flats, on both sides of the river, and between Breckenridge and Big Stone Lake toward the south. This flat surface passes by insensible degrees to one more rolling, and at the same time becomes more stony, toward the east, making the bulk of the Leaf Hills in Minnesota, and toward the west making the Coteau de Prairie in Dakota. It is essentially and typically a glacier-deposit, its varied aspects being due to the agency of water, present at the time of deposition, and either running with considerable current so as to wash out the clay and make stratified gravels and sands within the mass, as in the Leaf Hills and in the Coteau, or in the form of standing water, by which the clayey parts were retained and the whole spread out with a smooth upper surface, without much modification of structure.

After this drift clay was deposited there was for a long time a large lake of fresh water standing over the valley of the Red River of the North, which had an outlet toward the south by way of the Minnesota valley. This lake probably began its existence during the last period of ice, and was caused, at least during the latter part of its prevalence, by the glacier ice itself, which obstructed the northward flow which the natural slope of the country indicated and required. This lake began its existence on a much more restricted scale near Big Stone Lake, and it received and spread out evenly, as already noted, the glacier drift as fast as the glacier brought it forward. It grew toward the north as fast as the retreating ice sheet made way for it. At length, when there were partial or periodical openings in the northward outlet by way of Winnipeg, its shore line advanced or receded as the outlet opened or closed by the seasons of the waning glacial winter. Hence the

fine deposits which it spread widely during the times of its highest stages were withdrawn by the receding beach line during the time of its shrinkage and partial discharge northward. Hence the lacustrine clay is not spread so widely as would be expected from the existence of beach marks at some elevated levels.

It was the water of this lake during its period of agitation and instability that produced the next noteworthy member of the drift deposits in the Red River valley. This is a layer of gravel and sand, sometimes containing fresh water shells in abundance, as at McCauleyville, which nearly everywhere underlies the lacustrine clay and affords water. This sometimes is several feet thick. It lies directly on the upper surface of the boulder clay, but it does not extend generally over that surface where the lacustrine clay is wanting.

The lacustrine clay is horizontally stratified, and contains no stones (at least none have been seen) nor gravel. It is fine and close. It is of a yellowish or earthy color; or at considerable depth it may be bluish. It makes cream-colored brick. It contains less of the "alkali" than the drift clay Its area is about twenty-five miles wide in Minnesota, but it extends westward into Dakota with about equal width, or perhaps greater, and runs northward into Manitoba with an increasing width and thickness. It is barely found south of Breckenridge. Its special location is along the river, covering a belt on either side, and widening east and west up the tributary valleys. But the most of the surface of the Red River valley, within Minnesota, seems to be formed of the drift clay, showing stones and gravel in abundance. There is not much doubt that this lacustrine clay was once spread more widely over the surface of the drift clay, and was removed by the action of the slowly retreating shore line.

The latest of the surface deposits is the alluvium of the river, which sometimes becomes a very important one. Its amount and area are greater further north. While this is generally an incoherent, amorphous and arenaceous deposit rich in vegetable humus, and is confined to the immediate valley between the bluffs formed of the older foregoing clays, yet there are some places where it is more compact, and has an undulating stratification that somewhat resembles that of the lacustrine clay into which it then seems to pass. Such cases are not common, however. It is this deposit that bears the timber that occupies the valley. It is much more abundant where the lacustrine clay forms the river banks than where they are composed of drift clay.

The adjoining diagram, representing a transverse section of the valley at Moorhead, illustrates the superposition of these parts of the drift.

FIG. 1.

E

Section across the Red River Valley at Moorhead.

The Chemical Peculiarities of the Waters of the Valley.

In general the waters of the entire valley are alkaline*, whether taken from wells, springs or running streams. That is to say, they contain considerable amounts of lime, magnesia and soda, combined as sulphates, carbonates and chlorides. They are not often very bitter, indicating a moderate amount only of the chlorides of calcium and magnesium, but they contain on the other hand not a sufficient quantity of sodium chloride to allow of denominating them saline. The soda is probably in the form of bicarbonate, with a small proportion ot chloride, the lime as carbonate and sulphate, and the magnesia as sulphate. Indeed the most predominant taste is that of sulphate of magnesia, or epsom salt. The waters of the valley are not equally affected by these mineral ingredients. Those

*The analysis of the "alkali" of the western prairies, taken from the south bend of Moose river, in Dakota territory, by Prof. E. H. Twining, is given in the report of the Superintendent of Public Instruction of the State for 1870. [Ex. Docs. of 1871.]

1. Coarse gravel, principally quartz	28 per cent.
2. Finer material, principally quartz sand	18 per cent.
3. Fine dust, (passes through a sieve of 80 to an inch	54 per cent.
Total	100 per cent.

COMPOSITION OF NO. 3.

Loss by ignition (water and organic matter)	3.99 per cent.
Insoluble in acids (principally quartz sand)	67.47 per cent.
Soluble silica	1.36 per cent.
Sulphuric acid	7.43 per cent.
Carbonic acid	5.98 per cent.
Lime { Combined with Carbonic Acid }	3.62 per cent.
Magnesia { Combined with Carbonic Acid }	1.18 per cent.
Potash	1.05 per cent.
Soda	6.18 per cent.
Alumina and Sesquioxide of Iron	1.72 per cent.
Chlorine	Trace.
Total	99.98 per cent.

springs or wells that obtain their water from the drift clay a the most uniformly and strongly affected. Those whose source in the lacustrine clay, or from the sandy layer between it and t drift clay, are much less alkaline, as a general rule, though it is n at all impossible that that layer should contain water derived in mediately from the underlying drift clay, which would be as stron ly alkaline as any directly from the drift clay. The waters free from these mineral impurities are those found in the streams. these streams those will be found least alkaline that flow wholly mostly over the lacustrine clay, and hence they are in the northe portion of the valley, where the lacustrine clay spreads wider. T water of the Bois des Sioux is purer (so far as these ingredients a concerned) than that of the Otter Tail. The former is the outlet Lake Travers, and it is confined wholly to the immediate river va ley, having only inconsiderable streams flowing from the drift cl surface. The Otter Tail, on the other hand, rises in the Leaf Hil and flows for several miles, and nearly its whole course, over t alkaline drift clay.

These alkaline qualities are remarkably affected by organic i purities. In some of the natural waters of the valley this effect noticeable, particularly in those which are sluggish. Some lo grounds, in which vegetation grows rankly some portions of t season, but in which these alkaline waters collect and stand f some weeks or months during the early part of the following se son, are offensive with sulphuretted hydrogen, while the wate themselves are foul and sickening. Such effects are due to the r action of the decaying vegetable growths on the alkaline salts the water, which converts the sulphates into sulphurets, which turn are changed by the carbonic acid present, with the separati of free sulphuretted hydrogen, and the formation of carbonat The small streams of the valley are also apt to be nearly stagna during the summer season while they choke up with grass and ot er vegetation, and become heavily charged with organic matte These react on the sulphates and materially affect the mineral co dition of the waters, and their usefulness for domestic or agricu ural purposes. They generally continue to be used for wateri places for stock, and are sometimes hauled in barrels for househo purposes. If these reactions are perfectly balanced by even po tions of organic matters and alkaline minerals the soluble sulphat in the water may be wholly converted into insoluble carbonat thus mainly freeing the water both of organic acids and of the usu mineral ingredients. But this is usually not the case. In t spring months, and during wet seasons, the alkaline ingredien

overbalance the organic acids; but during the summer and fall, when the springs run low, and the developement of organic substances, and their decay, are most active, the organic impurities are in excess of the alkaline, and the waters show their worst condition —which is prolonged by the flatness of the surface, and the consequent slowness of natural drainage.

The waters of the valley generally do not have an offensive odor. It is only in stagnant and confined water these effects are noticeable. The chemical interaction is so slow that the resulting gas escapes unobserved, and the waters are slowly purified by the change. Suspended organic matter is also rapidly oxydized by contact with the atmosphere.

The following report of Prof. Peckham to Dr. C. N. Hewitt, shows more fully the chemical peculiarities of the waters of the valley from different localities :

Dr. C. N. Hewitt:

My Dear Sir—I have the pleasure of submitting the following report of the examination that I have just concluded of the specimens of water collected on our trip through the Red River Valley. They were gathered from the following named localities:

No. 1. The flowing well at Tintah, St. P. & P. R. R.
No. 2. St. Gabrielle Springs, near Campbell, St. P. & P. R. R.
No. 3. Well at Campbell Station, St. P. & P. R. R.
No. 4. Otter Tail River, at Breckenridge, St. P. & P. R. R.
No. 5. Bois des Sioux, at Breckenridge, St. P. & P. R. R.
No. 6. Well at Connelley's, on river, four miles northwest of Breckenridge.
No. 7. Wild Rice River, west of Fort Abercrombie.
No. 8. Well at Nolan's Hotel, McCauleyville.
No. 9. Well at Brewery, Moorhead (Artesian).
No. 10. Well at Bramble House, Moorhead (surface).
No. 11. Well at Glyndon, good—in general use.
No. 12. Well at Glyndon, bad, McLenan's.
No. 13. Town Well at Breckenridge.

They were selected for the following reasons:

No. 1 was from a well that was dug only a few feet into the level prairie, which furnishes a stream of water constantly flowing over its brink. The water of this well is considered of fair quality, and is used at several of the stations on the St. P. & P. R. R. in that vicinity. It was therefore thought best to examine it.

No. 2 is from St. Gabrielle Springs about 2½ miles from Campbell Station on the St. P. & P. R. R., situated on the banks of a small stream called Rabbit River. These springs are the only natural outlet for water in that part of the country so far as could be learned.

No. 3 from the well at Campbell Station was represented as being very bad, and quite unlike either Nos. 1 or 2. As this well was quite deep and in the immediate neighborhood of 1 and 2 it was thought desirable to know in what respects they differed.

No. 4 is considered by the inhabitants to be the best water in the upper Red River Valley, and with No. 5 is extensively used along the banks of the two rivers. As these two waters in mingling form the Red River, it was thought desirable to ascertain their quality and their differences, if such existed.

No. 6 was selected because there was reason to believe that it was the river water filtered through beds of gravel which formed the river bottom at that point. It was thought desirable to know if such filtration removed mineral matter from the water.

No. 7, from a tributary of the Red River has a bad reputation. It was thought advisable to compare this water with that of the Otter Tail.

No. 8 appeared to be bad from excess of mineral matter, and at the same time it was different from the well at Breckenridge. For that reason it was thought best to examine it.

No. 9 was selected as representing the water of a very deep well, and No. 10 as representing the water of a shallow well from the same locality, that had been recently dug. It was thought best to compare them.

Nos. 11 and 12 were from two wells very near together and very unlike, one being considered very good and the other very poor. It was thought best to compare these and ascertain if possible why the water in the bad well should have become sulphurous.

No. 13 was the town well at Breckenridge. When selected it was supposed to represent the bad well water of that locality. It was probably much worse than the average.

The accompanying table gives the results of the examination of these specimens. In estimating the total mineral and organic constituents, 100 c. c. were evaporated over a water bath and when dry the residue was heated to 130 deg. C. in an air bath. It was then cooled and weighed, and the amount calculated as "total solid residue." This residue was then heated over a Bunsen's lamp and the organic matter burned off. The residue remaining was calculated as the mineral matter in solution and the difference as volatile and organic matter. This difference can not be safely computed as organic matter excepting in those cases when the mineral ingredients existed chiefly in the form of bi-carbonates. Sulphates in some instances and chlorides in nearly all, retain water at 130 deg. C. and when the amount of such salts is comparatively large, they prevent the complete combustion of the organic matter by fusing and enclosing particles of carbon. No. 13 may be noticed as an example of this difficulty. The organic and volatile matter estimated from difference is 91.412 of which only 22.298 grains is actually organic matter.

The soap test was then employed to determine the total hardness, permanent hardness, and by difference, the removable hardness. Also the sulphuric acid, lime and magnesium. This test gave satisfactory results on all of the specimens but one. In No. 11 the permanent hardness was greater than the total hardness; that is, the water was harder after boiling than it was before. The tests were repeated until no doubt could be entertained of the fact. I cannot explain this anomalous result. For SO_3 the soap test appears to give very satisfactory results, but for lime and magnesia the process as described are highly empirical and give results of but little or no value except when applied to water containing

those bases as carbonates, and which at the same time is free from alkaline sulphates and chlorides. Waters containing the last named salts are rendered harder by them. If then the total hardness is used as a basis for the estimation of the lime, it is obvious on a moment's reflection, that if, as advised by Parke, the total hardness in tenths of a cubic centimeter be divided by four and a drop of ammonium oxalate solution added for every four degrees of hardness in a carbonated water, the same rule applied to a water containing alkaline chlorides or sulphates would cause an addition of an excess of the precipitant which adds to the hardness. For this reason I found it impossible to estimate the lime by the soap solution in Nos. 7, 9, 11 and 12. I have but little confidence in the results given for the other numbers. The magnesia was still worse for the entire hardness produced by alkaline chlorides or sulphates is included in the magnesia by Parke's method, as neither chlorine or sulphuric acid in combination with the alkalies is precipitated either by boiling or by ammonium oxalate. I have therefore omitted the estimates of magnesia in all cases as in those in which the determination was made. I had no reason to believe the figures reliable. The chlorine was estimated by a standard solution of silver nitrate, verified in No. 13 by precipitation and weighing; in which case the results corresponded to one one-hundredth of a grain.

We have reliable data therefore for comparing the waters in reference to the amount of mineral matter in solution, the total and permanent hardness, the sulphuric acid and the chlorine.

A comparison of the different specimens shows a range of amounts of mineral matter in solution varying from 6.304 grains to 390.158 grains in a gallon.

Numbers 13 and 8 are properly termed mineral waters. Numbers 1, 2, 3, 10, 11 and 12 are very hard well and spring waters; numbers 6, 7, and 9 are ordinary hard waters, while numbers 4 and 5 are quite pure river waters when we consider that they flow from and over sedimentary formations.

Numbers 4 and 5 are quite free from sulphates and chlorides. It will be further observed in reference to the remainder that with the exception of number 13 the sulphates are not extremely large, while again excepting number 13 the chlorides are very large, especially in numbers 7, 8, 10, 11 and 12. These results are unexpected, and I am especially surprised to obtain unmistakable evidence that the water of the Bois des Sioux river is purer than that of the Otter Tail—in fact is the purest water in the valley. A remarkable difference is also observed between the water of these rivers and that of the well at Conelley's. The mineral matter has increased about four fold, the chlorine seven fold, and the sulphuric acid three fold. These facts imply that the well water cannot be simply the river water, filtered through the gravel of the river bank.

So far as these results bear upon the subject of our inquiry they show that the waters of the Red River Valley do not contain large amounts of sulphuric acid, but that they are heavily charged with chlorides, probably largely combined with lime and magnesia. As a consequence they produce very hygroscopic residues when evaporated, and the accurate determination of the total solid residue or mineral constituents becomes extremely difficult if not impossible. An examination of the table shows that in every specimen in which the chlorine is large the organic and volatile matter is also large. This is not on account of an excess of organic matter but because the latter item is estimated by loss, and the loss consists of water retained at 130 deg. C., and also of a part of the chlorine from the decomposed magnesium chloride.

I cannot venture an opinion based upon these results, as to the cause of the water of many wells becoming fœtid on standing, or when the well is used but little or not at all. Number 11. is a colorless, odorless water, used by the entire population of Glyndon. Number 12. is from a well but a few rods distant from No. 11. It is of a yellowish color, contains a black sediment, and is heavily charged with sulphuretted hydrogen gas. Examination has thus far proved them to be of the same general character, with no difference in any respect that can be regarded as important. If the solution of this question is deemed desirable, I should recommend the selection of a number of typical specimens and their complete analysis, for organic, as well as mineral constituents. I should also advise a microscopic examination by an expert if possible. I would recommend as preliminary to the selection of these specimens, a further exploration of the valley, and an examination by the soap test, and for chlorine, of a larger number of waters, particularly those from springs, and if possible from wells that are free from exposure to filtration of surface drainage, and filth filtered from sink drains, barn yards, and the streets of towns.

As an illustration of the difficulties attending the drawing of any conclusions from the results thus far obtained, Number 9 may be mentioned. The permanent hardness is less than in any other specimen, indicating an absence of magnesium, sulphate and chloride. There was no calcium and magnesium chloride in the residue. Therefore, no water was retained at 130 deg. C. The 9.147 grains of organic and volatile matter is doubtless organic matter, and is a comparatively large quantity. The source of this organic matter it is impossible to determine, unless its character be ascertained. The water smelled as if contaminated with sewage from a sink, and may contain the soakage from the Brewery in which it is situated, or the organic matter may be derived from the clay. The bad well at Glyndon is near a barn, and the surface around it was covered with kitchen slops when the specimen was obtained. The residue from the water had a decided odor of urine. The question whether these organic contaminations are derived from the subsoil or from surface infiltration, becomes therefore a fundamental consideration, with reference to the prevention of cure of the undoubted bad qualities of most of the water examined. The amount of calcium bi-carbonate is not large in these specimens of water, while chlorides are abundant. It would not therefore be advisable to recommend the use of Clark's

Number.	Total Mineral Matter.	Organic and Volatile.	Total Residue at 130° C.	Removable Hardness.	Permanent Hardness.	Total Hardness.	Chlorine.	Sulphuric Acid (SO_3).	Lime (Ca O.)	REMARKS.
1	53.119	5.078	58.197	2.081	8.026	10.507	13.075	2.568	2.098	Colorless, odorless, had deposited iron.
2	62.458	12.316	74.764	10.216	15.468	25.684	10.623	4.202	7.647	" " " "
3	55.454	12.841	68.295	8.756	11.960	20.722	No estimate.	5.370	6.864	Turbid, odor of putrid brine ; iron.
4	8.279	4.142	12.421	.584	5.545	6.129	1.400	1.467	2.000	Colorless, odorless, had deposited iron.
5	6.304	5.137	11.441	3.210	4.086	7 296	1.400	.700	2.654	Yellowish, odorless.
6	26.617	3.210	29.827	3.210	7.880	11.090	10.098	3.502	2.980	Colorless, odorless.
7	33.156	11.440	44.596	0.000	8.436	8.436	28.077	0.000	No estimate.	Odor and taste swampy, yellowish.
8	196 656	34.556	231.212	43.779	20.430	64.209	42.728	(?)	6.864	Musty, dirty yellow, much iron.
9	31.988	9.147	41.135	12.550	1.167	13.717	9 740	2.334	No estimate.	Colorless, odor like a sink drain, deposit like clay,
10	48.967	43.662	93.629	9.340	6.712	16.052	156.204	2.334	2.918	Colorless, odor marshy, deposit like clay.
11	41.736	17.628	59.364	(?)	20.038	13.133	46.289	1.467	No estimate.	Colorless, odorless, deposit of iron.
12	49.675	20.488	70.163	3.502	5.837	9.339	56.096	2.200	No estimate.	Yellow, odor of H_2S, deposit black.
13	390.158	90.412	481.570	No estimate.	No estimate.	No estimate.	1.061	174.241	45.658	Residue on evaporation had the appearance and odor of a urine residue.

	Total Mineral Matter.	Water, etc. retained at 130° C.	Organic Matter.	Total Residue at 130° C.	Residue in $BaSO_4$.	Insoluble, H Cl SiO_2.	Fe^2O^3 and Al_2O_3.	SO_3.	Cl.	Fe_2O_3, Al_2O^3 and $Fe_2P_2O^8$.	Ca O.	Mg O.
13	390.158	69.114	22.298	481.570	51.542	4.412	3.035	174.241	1.061	10.723	45.658	29.443

Conclusions.

The foregoing ascertained facts will warrant the statement of sundry conclusions which may be given briefly as follows: They pertain to the solution of the question—whence come the foul odors of the wells in the Red River region?

1. The drift clay affords a strongly alkaline water.
2. The lacustrine clay affords a slightly or non-alkaline water.
3. There is generally a water-bearing stratum of sand, or of gravel and sand between the lacustrine and drift clays, which affords a good water in nearly all cases.
4. The drift clay comes largely from the disruption of the marine Cretaceous clays, and that accounts for its greater alkaline qualities—while,
5. The lacustrine clay is a deposit of superficial fresh waters.
6. There is a water-bearing stratum in or near the bottom of the drift clay which is under considerable hydrostatic pressure, and water from it rises nearly or quite to the natural surface.
7. Nearly all of the wells in the Red River Valley are curbed with wood of some sort, generally pine.
8. This wood undergoes rapid changes due to the chemical reactions between organic acids and alkaline waters, as above described under natural circumstances.
9. This source of foul odors is abundantly sufficient to account for all the phenomena.
10. The organic matters cannot come from the lacustrine clay, because the odors are equally prevalent all over the western part of the state where no lacustrine clay is found.
11. These organic matters cannot come from the drift clay, because they are found in wells that do not enter the drift clay.
12. Any organic matter in either of these clays would have long since passed through the stage of decomposition necessary for the production of such gases, and entered into a carbonaceous and fixed condition.
13. The assumed cause of these odors, whatever it be, must be one that is coextensive with the effects—hence,
14. They cannot come from surface indrainage, since they occur in wells where that is impossible.
15. They cannot come from sewerage or other artificial underground sources, because they occur generally in wells where such contamination is impossible.
16. This fermentation of the sap and pitch of the pine sometimes has the effect of giving the less alkaline waters of the valley, in its incipient stage, a taste as of kerosene, and the appearance of small globules and films of oily consistency and spacific gravity floating on the surface.
17. The effect of this change may be obviated, or mitigated, by copious use of the wells; and it may be wholly avoided by using earthen or iron pipes, and discarding the wooden curbing.
18. Shallow, open wells, dug in the surface of the prairie and having alkaline water, may become offensive in the summer, though without curbing, by the decay of fine organic particles blown into them, or washed into them, from the rank vegetation of the prairie turf.

In the progress of this investigation the writer became impressed with the sufficiency of pine wood to produce such odors, by a simple test experiment; viz:

Two quart glass jars were filled with good well-water, not alkaline, taken from the same well. Into one was put a quantity of pine chips, but into the other nothing was placed. They were exposed to the atmosphere of the same room, the glass stoppers being inverted and loosely placed over the wide mouths. While the jar with nothing but clean water remained clear and inodorous during the continuance of the trial, and indefinitely thereafter, the other went through the changes indicated by the following.

Records.

Dec. 4. Place a quantity of seasoned pine sticks in a wide-mouthed glass jar in common well water. The jar stands on a table in a warmed room, loosely covered by the inverted glass stopper. The sticks all float.

Dec. 5. A portion of the sticks have sunk to the bottom of the jar, and small bubbles of some gas adhere to some of them.

Dec. 6. Nearly one half of the sticks have settled to the bottom. The jar when uncovered smells strongly of fresh pine. Gas bubbles are more numerous.

Dec. 7. There is no noteworthy change.

Dec. 8. There is no noteworthy change, except perhaps a stronger pine odor.

Dec. 9. The pine smell is very strong, and less fresh.

Dec. 14. A thin scum floats on the surface. There is an odor of sourness.

Dec. 19. The floating scum begins to settle, some of it swimming in the water.

Dec. 21. The scum on the surface adheres to the glass, and looks gummy. The odor is less sour, and somewhat offensive.

Dec. 25. The odor is offensive, and there is a gelatinous gum adherent on the glass, and along the water level.

Dec. 28. The odor is strongly offensive.

Dec. 31. The odor is very offensive and foul, as from organic decay. There is a white, gelatinous or gummy scum, as of fungoid growth, adherent on the glass about the water level, and floating in flocks on the surface. It sometimes appears, especially on disturbance of the jar, in globular masses of $\frac{1}{3}$ to $\frac{1}{4}$ inch in diameter.

Jan. 1. The microscope reveals great numbers of organic germs, which are oval in shape and appear to be of the *Ciliata*.

Jan. 10. A jelly-like fungus, about a quarter of an inch thick, floats about in the water and on the surface. The odor is very offensive.

May 1. There is a swimming fungus which tends to settle to the bottom of the jar. The water is slightly turbid, and yellowish-red. It has a musty smell, and also is plainly acidulated. The microscopic animals are equally abundant, and of various forms.

In the presence of such a source of organic decay and contamination found in nearly every well in the whole region, it is evidently unnecessary, and even absurd, to search for any other.

These considerations bring up the whole question of the prevalence of typhoid fever as an endemic disease in western Minnesota and Iowa, but it is not germane to this report to enter on its discussion. Nothing more can be done here than to call the attention of those interested in the sanitary condition of the state to these facts, and to suggest that possibly the climate has less to do with such diseases than has been imagined, and that probably their causes lie nearer, and within the grasp of ordinary preventive measures. The effect of the water is not always an immediate typhoid fever, but an aggravated diarrhœa, and then dysentery, which lead finally to typhoid fever. This is the testimony of Dr. J. C. Rosser, of Brainerd, and also the experience and observation of many others. Sometimes the fever assumes a local name. At Bismark it is known as the "Montana fever." In Moorhead it is known as the "Red river fever," but they seem to be all essentially typhoid fever.

III.

RECONNOISANCES.

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1. *Into Wright County.*

Information having been received from Hon. William Pfænder of the existence of some evidences of coal in Wright county, an examination was made of the designated localities. On Sec. 33 T. 119 N., R. 25 W., land of John Marth and Fred Wanderzee, along the north branch of Crow river, pieces of Cretaceous lignite have been found in considerable quantities; also, along a creek, Sec. 25 T. 119 N., R. 26 W., on land of Joseph Plant. These are all float pieces, exactly similar to what have been found in numerous other places, though perhaps more abundant. An examination was made in company with Mr. John Marth, of Delano. The banks of the streams are composed entirely of drift, and largely of blue hardpan. The lignite was seen in the bed of the creek, having been most observed at or near fording places, where it was most likely to be brought to the surface and seen by passing travelers. At no point could any Cretaceous beds be seen *in situ*. Along the stream are numerous pieces of slate, or fissile shale, likewise derived from the Cretaceous, though here immediately from the hardpan drift. It is possible that Cretaceous beds would be struck below the drift, in sinking a shaft.

2. *In Rice County.*

In company with Prof. L. B. Sperry, a number of localities of rock-outcrop were visited in Rice county, for the purpose of determining the main characters and the continuity of the Trenton and Shakopee. The details of the geology of this county are given in the report of Prof. Sperry, and it would be simply repetition to give them here. The most interesting observation made, was the discovery of a carbonaceous layer in the Lower Trenton, exposed along Prairie creek, which without previous drying will ignite from a common match, and burn with a flame.

3. *In Goodhue County.*

The examinations made in Goodhue county were in compa with Hon. H. B. Wilson and Dr. W. W. Sweny, and consisted of visit to the quarries at Wanamingo, Zumbrota and Red Wing, a the collection of two boxes of specimens.

The eastern part of the county is rolling, with frequent rock e- posure in the brows of the hills, but the chief covering of the roc is the loose loam with a thickness of 50 to 75 feet, sufficient to mal the ascents generally tillable, while in the western portion the dri prevails so as not only to fill up the old rock-canons, but to conve the surface into an undulating prairie. The drift gradually thi out eastward under the loam. It seems to have suffered extensi denudation by aqueous forces, so that what is left of it visible u der the loam is coarse and gravely or stony. A very large bould of red or flesh-colored granite projects above the surface of the loa on N. W. ¼ of section 29, in Belle Creek. It lies on high land, ar is conspicuous from a distance. It rises about nine feet above t ground, and has a circumference of 26 paces. It belongs, of cours to the old drift epoch, and not to the last, as it is embraced in a partly covered by the loam, the loam not having covered general the newer drift in that part of the state. It is evident that the d nudation to which the old drift-surface was subjected, produced t material for fine clays which gathered in quiet spots, since under t loam, in old canon-valleys, and also in some places less protecte there are extensive laminated clays. The Red Wing pottery-cl comes from below the loam, on Sec. 3, Goodhue, Goodhue count and has a light gray, bluish color. The whole excavation was u fortunately covered by water, and nothing could be learned of t relation it bears to the drift or the loam. The Terra Cotta clay, Red Wing, is the blue interior of the terrace that accompanies H Creek. It is in horizontal laminations, and upwardly passes gra ually into the loam. Between the two drift periods it seems th the country had a forest covering, since in Goodhue county, no le than in Fillmore and Olmsted, there are abundant remains of ti ber and of the old soils. On Sec. 2, Wanamingo, on the high pra rie, land of Wm. Boulett, a log of what appeared to be hemlock, coarse pine, was found in digging a well, at the depth of 26 feet b low the surface. This was embraced in a "bluish-blackish" cla apparently a soil, and was five or six inches in diameter. It w covered with a hard, gravely, yellowish clay and by the loam th covers that part of the county. Also on Sec. 5, Belvidere, land John Holtz, in the valley of the creek, was found wood twenty fe

under the surface, in the gravely blue clay, or under it. On Sec. 24, Chester, Wabasha county, a log a foot in diameter was found in digging a well, upon the high prairie, said to be about twenty feet below the surface. This log was well preserved and could be chopped. It lay on the ground near the well for some years.

At Wanamingo the Lower Trenton is quarried in a low bench along the Zumbro. This bench rises higher and higher above the Zumbro in descending the stream, and finally the St. Peter sand rock appears, and then the Shakopee limestone, which, at Zumbrota, supports the south end of the bridge over the river, rising about 25 feet above low water. The stone for the abutments and foundation for the Forest Mills was taken out of this rock near the mills; but the stone for the bridge at Zumbrota came from the Trenton in higher land near Zumbrota. The Forest Mills are about two miles below Zumbrota. The Shakopee here causes a terrace-flat on which is situated Zumbrota village, but there is a covering of drift-gravel and loam.

A few aneroids were taken at Red Wing, and a general section was obtained of Barn Bluff. The top of the bluff is covered with loam, which also hides the rocks from sight down a sloping descent of about 70 feet. If this be regarded as containing limestone the thickness of the limestone will amount to 120 feet. From the top of this there may have been destroyed several feet of limerock. The general section then consists as follows, in descending order:

1. Slope and limerock...........	120 feet.
2. Sand and green-sand, and limerock,....................	40 feet.
3. Massive sand, the upper portion being white, the lower portion yellow. From this the glass sand is taken..........	50 feet.
4. Sand and green-sand, with cement of lime and magnesia, with distinctly aluminous portions. To the flood plain..	80 feet.

Barn and Soren bluffs dip toward the east a few degrees. There are extensive quarries in these bluffs, that furnish a fine building material. The stone now being used in the bridge over the east channel of the Mississippi at Minneapolis is from the quarries of Mr. Carlson in these bluffs.

4. On the Northern Pacific Railroad.

The details of this reconnoisance, so far as they relate to the water supply for domestic uses, are given in the chapter devoted to *Water-supply of the Red river Valley.* The only rock exposure along the line of the Northern Pacific R. R. after leaving the neigh-

borhood of the Junction with the St. Paul and Duluth R. R., within the State, occurs in the vicinity of Motley. This is a range of granite, about four miles north of the station, on sections 21, 22, 27 and 28, extending north and south. It widens out toward the north before disappearing under the drift. Its extent is about a mile across from north to south. The country round about for miles is nearly level, and covered with Pinus Banksiana, Larix. It escaped the observation of the land surveyors of the N. P. Company, and the land was entered and described as having "no stone." There are here hills and ridges that rise fifty or seventy feet above the surrounding country, and in some of them the rock is bare. It cannot be said with certainty that this rock exists in all these hills and ridges, but it probably does. There are but few spots where any drift boulders can be seen, the country—even these hills—being covered with sand or sandy loam. The surface of the rock is old. It does not show recent glaciation, the appearance it presents being rather that that would be attributed to aqueous forces. The surface is, in general coutour, *moutonne-ed*, but not so markedly as the knobs and hills of Marquette and Duluth. Since this glaciation it is evident that water has covered this rock for a long period—water probably which spread the fine sand over so wide a belt, extending almost uninterruptedly from near Thompson to this place.

The rock rises in undulating sheeps-backs, and in the intervals is covered with sand and turf. It consists, taken all together, of at least three different qualities, viz: First, a gray syenite (?) which has a greenish mineral like serpentine and also both white and flesh colored pieces of feldspar, rather fine grained. Second, a dark, diorytic, trappean rock that occurs in apparent, wide dykes in the granite. This varies from a petrosilex, (or what may be taken provisionally for that rock) to a real dioryte. Third, a serpentinous granite, i. e. a granite (with white feldspar) that contains a green mineral undistinguishable from the green mineral of No. 1, with evident lumps of mica. These three kinds may not be the only variations that the rock will on quarrying exhibit, but they are the only noteworthy ones observed. They are all rather fine-grained. The green mineral of No. 1, is sometimes more abundant in streaks or veins, even two inches wide, than throughout the rock, giving the rock a striped aspect, often two or three thin veins coming within a foot. This rock was discovered and purchased of the N. P. R. R. by Mr. C. H. Alsop, who is beginning to open it for sale. Being in the midst of a country destitute of known rock, especially of granite, this locality has much importance. It will furnish a building material of the most durable kind, and possessing all the excellencies of the granite of St. Cloud or Sauk Rapids.

From Brainerd to Motley the country is about the same as at Brainerd, i. e., a sandy plain. The timber consists largely of Bank's pine. Wadena and Perham are on prairie openings. At the latter place the subsoil is a gravel-and-sand to the depth of at least 15 or 20 feet, as revealed by wells that get good water at that depth. This gravel-and-sand is like that on which Minneapolis stands, but is not overlain by so distinct a loess loam. The loam here is only soil-deep, and also contains occasional little pebbles, the same as found in the gravel below, showing that the loam is only a soil formed from the sand and gravel of the subsoil. This subsoil of gravel-and-sand continues westwardly, through and beyond the prairie on which Perham stands, and into a sparsely timbered and undulating country, even beyond Frazzee City. It is noticeably *free from boulders*, and consists only of gravel and sand. On approaching the Leaf Hills the gravel and sand becomes gradually coarser, with occasional stones, the general surface also becoming more broken. Further on the gray hard-pan, very stony, comes in, at first gradually as if the gravel and sand were horizontally merged into it by the accession of clay and larger stones, but finally so as to comprise the mass of drift, as seen in the cuts by the grade of the road. The hills are composed of this hardpan. At Detroit the surface is undulating and somewhat rolling, but mostly a prairie, being fairly on the west side of the Leaf Hills. There is a little timber west of Detroit, but the prairie sets in within a couple of miles, and continues to Moorhead. The subsoil at Detroit is the same as at Perham, a gravel and sand, the surface-soil being a loam, derived locally from the subsoil by disintegration and the action of vegetation. The roads are always dry; the wells go into gravel for water at the depth of 25 or 30 feet, the supply being good—limy or chalybeate—and copious.

Above Brainerd about five miles, are the French Rapids, in the Mississippi river. Their immediate cause is a quantity of drift boulders, which lie mostly along the left shore, though they are also of course throughout the bed of the channel; but their original cause is probably the nearer approach of the bed-rock toward the surface of the drift. A short distance above these rapids, on the left bank is a high drift bluff composed largely of clay, but containing numerous stones and boulders. Below the rapids the river runs along the left side of an alluvial, timbered island. The fall in the rapids is about three feet. No bed-rock can be seen. There are a few boulders also along the right bank just above the head of the rapids. The bottoms are covered with deciduous trees, but the upland mainly with Banks' pine, with some white and Norway pine.

East of Brainerd the country is mainly one of plains, which are superficially sandy, but they must be closely underlain by a clay deposit, since they often become wet, when large swamps are caused by the contained water. There are also numerous ridges of hard-pan-clay soil and subsoil, in which a different outward appearance is very marked. The trees become larger, and consist of a greater proportion of deciduous species, while the Banks' pine entirely or almost wholly disappears, and the Norway and white pines prevail. Toward the Junction the hardpan clay comes in in full force and continues to Duluth, except when overlain by the red laminated lacustrine clay of Lake Superior.

At the Northern Pacific Junction, prominent .and bare ridges of slate, four to six in number, rise about 25 to 40 feet. They run nearly E. & W., or by compass north 80 degrees east, varying to north 75 degrees east. The slaty cleavage runs nearly parallel with the direction of the ridges, or north 85 degrees east. In approaching from the west, along the N. P. R. R. this slate becomes perceptible a short distance before reaching Komoko; and, by the topography and changed drift, rock is evinced for several miles even before reaching that place. These ridges run through Komoko and the N. P. Junction, and at least to Thompson, where they have been wrought, the slate quarries being about two miles from the railroad in Sec. 29, T. 49 N., R. 16 W. They are not continuous, nor uniform in height nor in length. They rise, and sink again below the surface, with an irregular alternation. Sometimes a section across the range would show only three or four series and sometimes there might be six. Often the intervals in one series are opposite the ridges in the adjoining one. The rock itself varies from an argillyte suitable for roofing, to a very dark, or gray quartzyte that shows less slaty cleavage, yet must probably be taken as a part of the same slate group. The rock of this latter kind seems to be found in some of the ridges exclusively, while the argillyte prevails in others. Outwardly they have about the same appearance, as they lie in long parallel, undulating ridges, and perhaps they should not be so prominently distinguished as this description implies. These ridges are moutone-ed, but there are no scratches or other marks showing the direction of any glacial action. They have three systems of jointage planes crossing each other at various angles, so that the rock itself is cut into large angular blocks to great depths, which not only facilitates the quarrying of the slate, but the natural disintegration of the ridges by frost. The adjoined sketch shows a ground plat of one of the ridges, with the different systems of joints:

FIG. 2.

Ground plat of a slate ridge at Junction.

Explanation of Figure 2.

1\. 1. Slaty cleavage, nearly perpendicular, runs north, 85° east.

2\. 2. Joints that cut the slaty cleavage at right angles, but slope west at an angle of about ten degrees from a perpendicular. They are sometimes so numerous as to number four or five in the interval of a foot.

3\. 3. Joints (or bedding) which run parallel with the ridges, but slope south at an angle of about 45° with the horizon. The southern slopes of the ridges are formed by the splitting off of the layers, while the northern slopes are apparently caused by the breaking off, by an irregular and shifting fracture of the same layers, and have an angle about the same as the southern slopes, but in the opposite direction.

4\. 4. Less distinct oblique joints that do not seem to be as numerous as the foregoing, but which, on the quarrying of the rock, are seen to penetrate to as great depth. These aid in causing the superficial parting of the rock into rhomboidal and angular masses. They slope N. W. at an angle of about 25° from a perpendicular.

The horizontal extent east and west is about six rods.

Figure 3 is a perpendicular section running north and south across these ridges, showing the direction of the slaty cleavage and of joints 3. 3. of Fig. 2.

This slate appears to be the same as seen at Little Falls, on the Mississippi below Brainerd, but it here shows none of the concretionary hornblend, or dioryte rock, and, taken all together, is somewhat finer grained, not showing an evidently micaceous composition.

FIG. 3.

Section across the slate ranges at Junction.

IV.

THE GEOLOGY OF MORRISON COUNTY.

This reconnoissance was made in company with Mr. N. Herrick, of Minneapolis. The first observations were made at Pike Rapids, which are at the mouth of Swan river, but are in the Mississippi. They are so named from Lieut. Z. M. Pike who built a stockade and wintered with his men here in 1805–6. They are caused by a mica schist rock which rises in some spots about six feet above the water at low stage, but lies mainly in the river channel. The only outcrop on the shore seen being in the left bank. The schist is filled with small crystals of garnet and coarse crystals of staurolite. Besides these clumps of schist rock rising in the channel of the river there is an abundance of boulders of all kinds, both in the river and on the shore, the banks rising about 30 feet and consisting of coarse material. The rock itself seems to dip, at least it has a laminated structure which dips, toward the northwest at an angle of about 4[illegible] deg.

At Little Falls the rock that occurs in the river is a roofing slate similar to that at Thomson, but varies from a mica schist to an argillyte, with some veins of white opaque quartz. The rock in some places also varies to a massive, compact hard rock with sharp jointage angles, whch, when broken, has nearly the color and texture of the staurolite crystals, if fractured, found in the rock at Pike Rapids, but seems to be more nearly a dark quartzyte. Besides these variations there are nearly continuous layers of more or less lenticular and concretionary lumps or nodules, sometimes six or eight inches thick, of a rock very firm and dark-colored, but which on weathering becomes superficially lighter-colored and shows needles and spangles of dark-green amphibole. The matrix in which these crystals lie is not well characterized, but is quartzytic and perhaps also feldspathic, but is dark-colored, so that on a fresh

fracture the amphibole crystals are hardly observable. They appear on the weathering of the rock. By far the greater part of the whole is a micaceous argillyte, with slaty cleavage nearly perpendicular, or sloping a very little toward the N. W. (N. 18 deg. W.), the strike being N. 18 deg. E. There is also a system of joints that gives the rock, viewed across the river, the appearance of being conspicuously stratified, with a dip up the river of about 45 deg. from the horizon. The slatiness, which is nearly perpendicular, is somewhat injured, at least superficially, by the frequency of joints, of which there are at least two systems intersecting each other at a small angle, thus cutting the slates into rhomboidal masses, as they weather to pieces. The following diagram (Figure 4) is designed to show the relation between the slates and the three systems of joints mentioned. The general exposure is an irregular expanse in the river channel, and bottom land, but does not rise in ridges or knobs, though the occurrence of a dyke of dark trap, and the massive quartzytic rock, seem to have been the primary cause of this protrusion upward of the underlying formation which is generally more deeply buried under the drift. This is known to extend under Little Falls village, being encountered in wells and cellars.

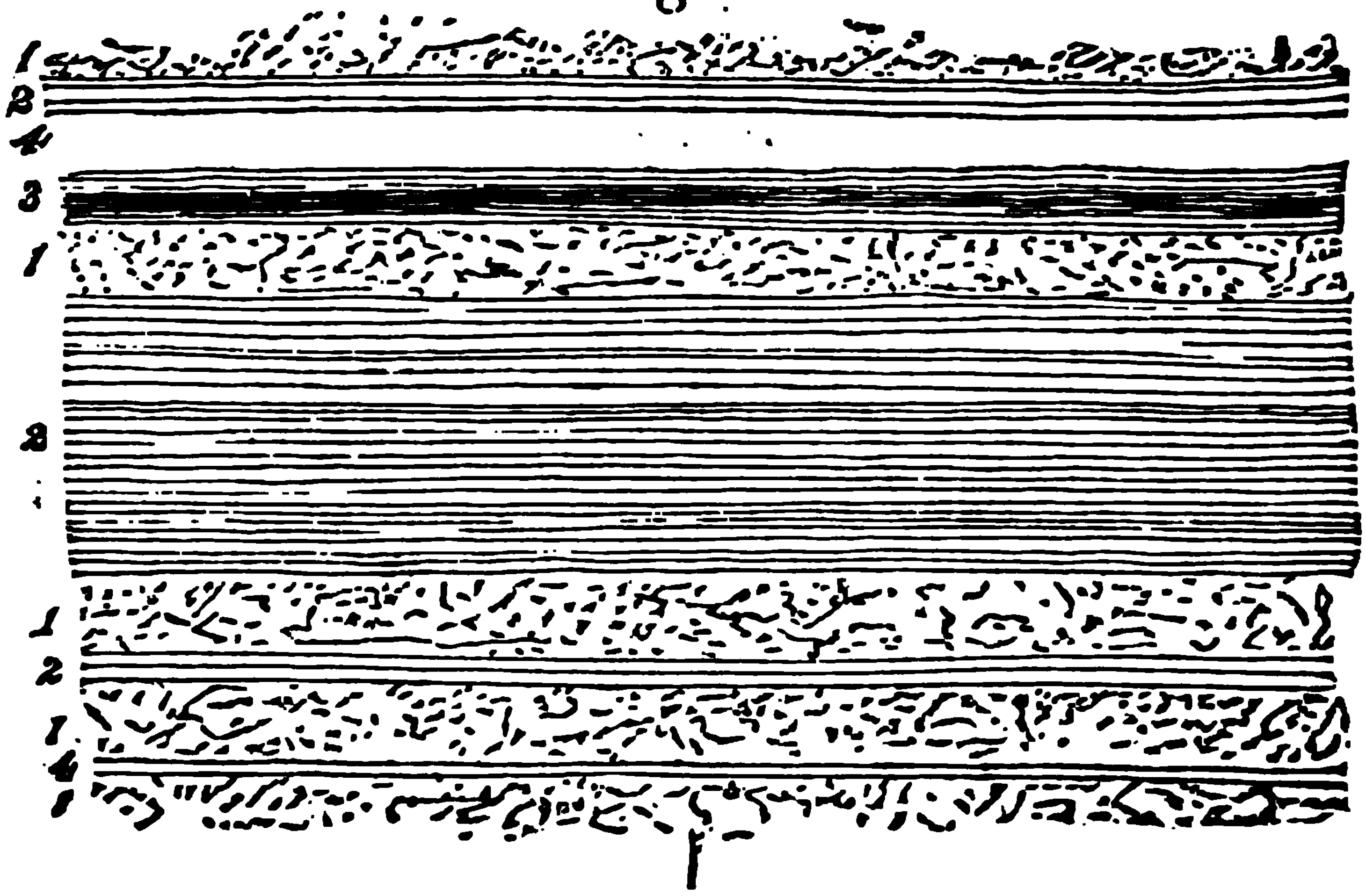
FIG. 4.

Jointage of the slate at Little Falls.

A little distance further down the river, yet scarcely outside the limits of the village, rock is exposed on "the point," and consists, in general, of a hard, dark-colored dioryte, containing mainly amphibole in coarse crystals, and a little feldspar (labradorite?). The outward characters of this rock are the same as the concretionary lumps that exist in the slate already described. It is here simply in larger area and bulk. It is parted by joints that cause it to fall to pieces in slabs and cuboidal masses. This *may be* here in the form of a dyke, but its relation to the slate cannot be seen. The point which is formed by it is considerably higher than the bottom land on either side, but falls away somewhat on receding from the river, the rock itself becoming lost to view in the swampy bottoms, or involved with the drift of the river-bluffs. On long-weathered surfaces, under the action of the water, there is a ridged and furrowed form that shows the same direction and trend as the slatiness of the slate, i. e. N. 18 deg. E. These ridges are about ¼ inch apart, and about ⅛ or

¼ inch high, separated by intervening furrows. This surface configuration is apparently due to the alternate arrangement of the mineral contents, and perhaps has its origin in a metamorphosed condition of the slate itself, or of the sedimentary rocks from which they both may have been derived. Thus this could not be of the nature of an igneous dyke, but a metamorphic variation due to the complex nature of the original sediments. This view is strengthened by the occurrence of a similar diorytic rock, in concretionary masses in the slate itself, running in more or less regular layers or lines. This alternation of mineral contents does not pervade the whole of rock exposed on "the point," but it is a conspicuous feature in some places. The ridges are composed of the lighter colored minerals and the furrows of the amphibole. The adjoining figure (Fig. 5.) illustrates the alternation of these ridges and furrows.

Fig. 5



Arrangement of Mineral Contents at Little Falls.

Explanation of Figure 5.

1. Bands of dioryte.
2. Alternating bands of amphibole and feldspar.
3. Furrow mainly occupied by a band of amphibole.
4. Feldspar band.

Opposite the village of Little Falls a trap dyke of basic doleryte, apparently about 10 feet wide, appears in the slate, going diagonally across the slate; and on the south side of the dyke, in the lee of its protection against the current of the river, as well as against, possibly,

the ice of the ice-period, the slate (or schist) is decomposed to the depth of four or five feet at least, making a greenish-blue clay, or incipient kaolin.

The slate at Little Rapids is visible, along one or both sides of the river, as far up as the ferry, perhaps three-quarters of a mile above the village.

On the N. E. ¼ Sec. 13, (R. R. land), Little Falls town, on the west side of the river, is an area of dark granite, rising in smooth knolls a few feet above the surrounding country, which is flat and rather wet, though sandy, and in fact is an eastward continuation of the flat of the west bank of the river at Little Falls. This rock is not in all places a true granite, but varies to a dark, apparently trappean rock, which is an amygdaloidal melaphyre*, containing, however, a light-green mineral like serpentine. There are also variations to a non-amygdaloidal melaphyre with scattering mica-scales.

At the mouth of the Little Elk river, two and a half miles above Little Falls, the slate seen at Little Falls again appears, but here the direction of the slatiness is N. 30 deg. or 35 deg. instead 18 deg. east. The creek runs across it and cuts into it. The dam is made between the rock bluffs on either side. The slate is known to extend up the Little Elk only about half a mile.

N. E. ¼ section 26, Belle Prairie. Here is an outcrop of granite. It rises not more than eight or ten feet above the general surface, which is nearly level. It is rounded over but is not striated. Its color is sometimes pink and sometimes gray. It is rather massive than schistose. Its area probably extends over on the next section north. Similar rock occurs again about two and a half miles northeast of this place on section 18, in the next town east.

PRIMITIVE MAN AT LITTLE FALLS.

(1). The Stone Cutters.

During the examination of Pike Rapids some search was made for ike's winter stockade. Near the principal exposure of the bed-rock, ong the east bank, abreast of a small island scantly turfed over, iere is a blind excavation in the river-bank which consists of loose

* This term is used here in the indefinite sense preferred by Bernhard Von Cotta.

sand and fine gravel, that has the appearance of having been artificial, but no old timbers could be found in the vicinity. Paris Roy, a half-breed living at Little Falls, says he remembers hearing his uncle, a trader for the American Fur Company, named Charles La Rose, stationed seven or eight miles above Little Falls, at that time, relate the fact of Pike's stopping here and describe the place as on the east bank, and below the rapids. This excavation is really below the main rapids, though there is half a mile of rapid water below it, caused by boulders, without exposure of the bed-rock.

About this excavation, which may or may not have been the site of Pike's stockade, are pieces of chipped white quartz, which from their sharpness, and their color, indicate an artificial origin, and attract the eye of the visitor. It was only after a handful had been gathered, that at last an imperfect arrow-head was found. These chips, at this point, were found only over a small area, indeed they were not looked for at other points up or down the river, nor at any depth below the surface. This quartz, which is white and opaque, was evidently taken from some vein in the slate in this neighborhood, for the slate at Little Falls has several veins of that kind of quartz.

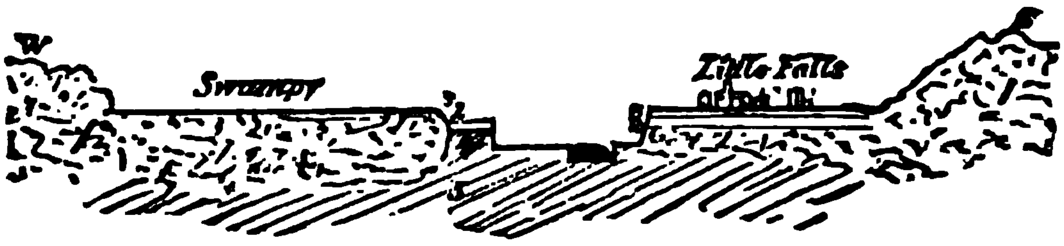
Subsequently however, these chips were found to extend over a larger area, and to be incorporated with the materials of the river banks. Further examination at Little Falls disclosed this interesting discovery. They are found, not only on the surface of the flat on which Little Falls village stands, especially near the river, but on excavating the bank near the river, making a perpendicular section, they are found to extend downward three or four feet into the sand and gravel. A person in digging half an hour might find twenty-five or thirty. The material in which they occur is a homogeneous sand, passing downward gradually into a coarse sand and finally into a gravel. This flat along the river on the margin of which they are found, is about twenty-seven feet above the river, and is now never covered by it. The bank itself may be divided into three parts, as follows, in descending order:

1. Loam sand, gravelly below.
2. Gravel, becoming stony below.
3. Hardpan-drift, containing boulders.

The plain on which Little Falls stands, is about a mile wide, and extends along the river, as an abandoned ancient flood-plain, southward, and becomes that on which East Minneapolis is situated. Toward the south its average width remains about the same as at Little Falls—perhaps becomes less—but toward the north it increases in width, and at the same time rises above the river, and finally

comes apparently to constitute the entire country about. Brainerd (with the sandy country east of it) is on such a plain; towards the west a sandy plain of the same nature, and the same level extends much further, though, opposite Little Falls, it is occupied to a large extent with wet land and often by tamarack swamps. On either side of the river, outside of this plain, is a line of drift bluffs which have a rolling coutour and rise from 50 to to 75 feet higher, constituting a greatly different character of country, and occupying the general level for an indefinite distance east and west from the river. Northward from Little Falls, while the included plain becomes wider, and covered with a coarser sand, these bluffs gradually become lower. It seems as if the plain slowly rises to the level of these drift-bluffs, and the bluffs themselves then are lost to view, or are so broken, and involved with other drift knolls and ridges, that they seem to have no relation to the river itself. In traveling by the new railroad, lately constructed between Brainerd and St. Cloud, this change is observable. The road itself, at least between Little Falls and Brainerd, runs throughout on this plain. In reverse order the depth of the river below this plain increases in going northward. At East Minneapolis it is from 25 to 30 feet above low water; at Shingle creek it is about 37 feet; at Champlin it is 43 feet; at Dayton 45 feet; at St. Cloud 58 feet; at Brainerd about 60 feet. No measurements have been taken above Brainerd. Along the river at a lower level is another flat, or bottom-land, which is the present flood-plain. The hardpan drift which prevails in the bluffs on the east side of the river, and which underlies the sandy plain above described, seems to be of the old drift epoch (see report on Hennepin county for 1876), and lies on the slate at the Falls. The adjoining diagram (Fig. 6) represents a section across the Mississisippi valley at Little Falls:

FIG. 6.



Section across the Mississippi valley at Little Falls.

Explanation of Figure 6.

1. Hardpan drift, on the east side covered with a fine clayey loam.
2. Gravel and sand.
3. Sand, loamy above and gravelly below; 60 feet above the river at low water.
4. Trap dyke.
5. Slate rock.

The quartz chips occur in No. 3, and abundantly on the flat (somewhat lower than the average here) directly opposite Little Falls, in the neighborhood of the trap dyke. They extend up and down the river also an unknown distance. They were found at the mouth of the Little Elk, two and a half miles above Little Falls. The belt on the west side which seems to afford them is about 40 or 50 rods wide, but something less than ¼ mile on the east side. On the west side they appear in the soil when large trees tear it up.

These chips are all angular, some of them being as sharp as knives, and perfectly unwaterworn, and they occur in a waterworn deposit. They vary in thickness from that of paper, and the size of one's fingernail, to one and two inches across, of irregular, angular forms. Almost no other coarse material is found in the surface sand in which they are found; and whatever there is, is waterworn and rounded. The chips are generally without evidence of designed form, and nearly all the angular pieces are also destitute of all evidences of artificial shaping, so far as their forms are concerned. Only a few pieces were found that seemed to show the work of careful chipping, and they are not perfect. The most certainly chipped form found was taken at Little Elk river, but was of brown chert. Some of these chips are represented on Plate I.

The interest that centers in these chips, and which alone would warrant this extended account of them, involves the question of the age of man and his work in the Mississippi valley. When they were first observed they were taken to be of much later date than they seem to be, indeed they were associated with the builders of the mounds and ridges that are seen at Little Falls and many other places in Minnesota, attributable to a race known as the Mound-Builders, who preceded the present Indian races. But these mounds and ridges at Little Falls are built of the very sand, and are situated on the very same plain in which these chips occur. In other words, the Mound-Builders dwelt at Little Falls since the spreading of the material of the plain: hence they are post-glacial. The chipping race, if these chips are of human origin, preceded the spreading of the material of the plain, and must have been pre-glacial; since the plain was spread out by that flood-stage of the Mississippi river that existed during the prevalence of the ice period, or resulted from the dissolution of the glacial winter. The fortunate juxtaposition of these two classes of human remains enables us to establish this important general truth. The wonderful abundance of these chips indicates either an astonishing amount of work done, as if there had been a grand manufactory in the neighborhood, or an enormous lapse of time for its performance.

EXPLANATION OF PLATE.

(*See Page 56.*)

FIG. 1, *a*. Convex surface of a chert implement found at the mouth of Little Elk river, Morrison county, supposed to be a scraper.

FIG. 1, *b*. Profile view of same.

[NOTE.—This specimen is regarded a finished implement by F. W. Putnam, of the Peabody Museum.]

FIG. 2, *a*. Convex surface of a chert implement found at Little Falls.

FIG. 2, *b*. Profile view of the same. The figures do not perfectly represent the evidentally chipped edges.

FIG. 3, *a*. Broken arrow-head (?) of white quartz, found at Pike Rapids.

FIG. 3, *b*. Profile view of same.

FIG. 4, *a*. Scraper (?) of white quartz, from Little Falls.

FIG. 4, *b*. Profile view of same.

FIG. 5, *a*. Implement of white quartz, Little Falls.

FIG. 5, *b*. Profile of the same.

FIG. 6, *a*. Implement of white quartz, Little Falls.

FIG. 6, *b*. Profile of the same.

These figures are all of the natural size of the specimens.

There is one other source to which these chips can be referred. The veins of white quartz traversing the slate at Little Falls, from which these chips were originally derived, were observed in one instance (near the mouth of Little Elk river) to split into angular pieces similar to those taken from the surface sand of the plain, under the action of moisture and frost. This was seen at a point where the freshet water of Little Elk river had lately carried away the surface materials, laying bare a large area of the slate. The quartz of the vein, not having a mineral cleavage, yet had an irregular fracturing tendency which resulted in the disentegration of a considerable quantity of the vein. It is supposable that in some earlier history of the river, when it was large enough to cover the whole valley from the drift bluffs a mile east of Little Falls to the drift bluffs several miles west, this same disintegration under natural causes took place, and that by some means the fragments were distributed by the water of the river, perhaps by floating ice, over the flat on which they are found when it was the bottom of the river. This supposition meets with the following obstacles.

1. There is no point throughout the whole region round about where the slate conveying these quartz veins rises to the level of the surface of this plain so as to be within the range of transporting agencies, whether of the water of the river or of floating ice, but the quartz veins are from 40 to 50 feet lower than the flat on which the chips occur.

2. During the high stage of water that formed the chip-bearing terrace, that plain itself was intact from side to side, the present river channel which is cut down to the slate and the quartz veins, not having been excavated.

3. The chips seen at Little Elk river, resembling these supposed human remains, were in the bed of the river, and *under* the drift originally, even the unmodified glacier drift, while the transported chips are *over* the glacier drift and in a water-washed sand.

4. If these chips were the product of natural disintegration, and river distribution they would be expected to show some attrition incident to the long period of wearing they had passed through. On the contrary, while embraced in a water-washed and rounded sand, or fine gravel, they are themselves not worn in the least.

5. The quartz fragments, while mainly destitute of evidence of designed shape, do in a few cases appear to be imperfect forms of arrow-heads or of cutting or scraping instruments, and also have, along the edges, the appearance of having received repeated blows, and present small fresh surfaces of forced fracture.

6. In gathering about three quarts of these chips, eight pieces were found that could be thought to have a designed form, and two of these are of brown chert and undeniably the product of human design.

(Since the foregoing was written, some of these chips have been submitted to Mr. F. W. Putnam, Curator of Peabody Museum of Archaeology and Ethnology, Cambridge, Mass. After an examination he says he has no hesitation in saying that he "considers them identical with those known to be formed by the hand of man when making implements of stone." One of the chert specimens he regards "a finished implement.")

(2.) The Mound Builders.

Mention has already been made of ridges and mounds on the terrace at Little Falls attributable to the early race known as Mound Builders. They have a general resemblance to many others that may be seen in the State, some of which have been alluded to in former reports (Reports on Houston and Hennepin Counties). Their occurence at Little Falls is interesting especially in relation to the possible human origin of the quartz chips that have been described, as they seem to be of later date than the chips. This is proven by the fact that the mounds are built on the terrace plain, and of its materials, in the composition of which plain the quartz chips take part, extending three or four feet below the surface. The mounds themselves are somewhat different from those seen elsewhere, inasmuch as they consist of low, circular ridges, from eight to twelve feet across, rising but two or three feet above the general level. These are scattered over a small distance on the east bank of the river near the northwest corner of the village plat, though perhaps others would be discovered on making a more extensive survey. The following diagram of the surface shows their position relating to the river and the other ridges. They may have been designed for habitation, having been formed at first by slightly excavating the surface of the ground, and then building rude arched coverings supported by wooden branches and enclosed by earth. As these decayed and fell in, the resulting forms would be exactly what are now seen. Beyond the limits of the village, further north, is an interesting ridge, nearly straight, running obliquely back from the river and a hundred and eight paces in length. This is of a very different nature, though plainly artificial. It is from three to four feet high. It has two low spots, or openings through it, which separate it into three main parts. It does not extend to the imme-

diate river bank, but is separated from it by an interval of several rods. The design of this ridge is not evident, but it must have had some relation to other works in the neighborhood. It may not however, have the same age as the small circular ridges above mentioned, since there is some possibility that the latter may have been built by the present Indian races.

About fifty earth-works or mounds are found on the border of a small lake on Sec. 35, Belle Prairie and Sec. 9, Little Falls, six miles east of the village of Little Falls. They follow round the shore of the lake, which is know by the Indians as "The Lake between the Hills."

FIG. 7.

Mounds and ridges at Little Falls,

(3.) *In other parts of Minnesota.*

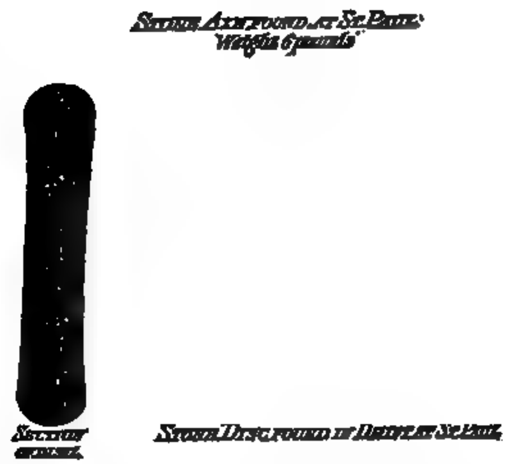
A great many flints and stone implements have been found in the State indicating the former prevalence of a race, or races, analagous to the stone-workers of Europe. Whether these stone implements are referable to the older stone-working race, which would make them pre-gracial, (palæolithic), or to the more recent nolithic stone-workers, or to both of them, has not yet been ascertained; but the disposition has been general to assign them to the latter. It may be possible, however, that the palæolithic race is represented, and the quartz chips at Little Falls would seem to indicate that to be the case. At any rate the most careful attention should be given to the relation of all such discoveries to the drift of the region in which they occur.

A few of the other evidences of palæolithic man in Minnesota may be mentioned. Dr. A. E. Johnson mentions in the Bulletin of the Minnesota Academy of Natural Sciences for 1874, the discovery of human bones in the sand and gravel of the Mississippi river in

the eastern terrace bluffs, at Minneapolis, coincident in age and hight with the terrace bluff in which the quartz chips occur at Little Falls, this being a deposit coincident with or immediately following the last glacial epoch. On the same authority two fragments of a human lower jaw with teeth were discovered in the "red clay and boulder drift" near the Falls of St. Anthony, by workmen excavating in it for use in the tunnel under the river, lying "immediately upon the limestone ledge." This red clay is the product of the first, or oldest known, glacial epoch, and lies below all the other drift. He also states that on the same side of the river a copper spear-head was taken from a crevice in the limerock of the Lower Trenton, where its strike forms an elevation in the alluvial plain of the terrace above mentioned, at some distance from the immediate river, under four feet of drift—"sand, gravel and clay"—which is now in possession of the St. Paul Historical Society. This deposit is of the same plain and date, as the material of the terrace containing the quartz chips. The spear-head is said to have been three feet within the lime-rock. It must be admitted, however, that, supposing these human bones and teeth to have been found in the manner reported, they may still have been the result of more modern burials, and the spear-head may have been thrust in the crevice (a weathered and eroded jointage-plain) horizontally, instead of perpendicularly, as these open crevices abound in the Lower Trenton and appear on the exposed wall of the rock facing the river, and especially in that part of the ancient channel which was cut prior to the last glacial epoch, where this spear-head was found. The locality of the Falls must always have been a resort for rude tribes of men, and a great many burials, not to say battles, may have taken place here. Still there is an appearance of authenticity about these discoveries, so far as the published facts go.

A stone axe weighing six pounds was found at St. Paul in digging a cellar near the Adams school house, by Jacob Biska, six or eight feet below the surface. It was overlain by soil and black loam, which has a thickness of eight or ten feet at that point. The figure below shows its outline. The surface of the blade end is smoothed, or roughly polished, but the other end is rougher, or weather-worn. This lay in the latest of the drift deposits, but far beyond the reach of the present river, though within the outer drift bluffs.

FIG. 8.



Stone axe and disc found at St. Paul.

In a gravel bank at St. Paul also was found recently by Mr. Mervine, a stone disc about two inches in diameter, and three-quarters of an inch in thickness. This has a circular depression in the center. One side is coated with a limy crust. It is of a fine-grained greenstone.

The remains of an extinct elephant, in the form of a tooth and tusk, were found in the gravel and sand of the east bank of the Mississippi about five miles above Minneapolis. These occupy the same relation to the river and the valley as the quartz chips at Little Falls, having been taken from the same terrace.

In the coarse river-gravel at Stillwater, far above the present river, but within the main valley, was found a mastodon's tusk, and about eight feet of it are preserved in the Academy of Sciences at St. Paul. This was taken out in the year 1856 by A. Van Vorhes. The section of the bank in which it was found is now made up as follows:

1. Disturbed sand with some boulders.................... 5 feet.
2. Fine sand, with nearly horizontal strata............... 2 to 6 feet.
3. Gravel and boulders................................ 0 to 4 feet.
4. Very fine, handsome sand, in horizontal stratification... 15 feet.
5. Coarse gravel and boulders.......................... 4 to 6 feet.
6. Horizontal strata of fine sand.......................30 to 40 feet.
7. The "tripoli" bed lies next below this fine sand.

The tusk was found in No. 6, and near the bottom. Near the top of the same stratum, Mr. Van Vorhes found fragments of pottery having carving and ornamentation. These are all to be seen in the Academy at St. Paul.*

In the possession of the Minnesota Historical Society are two immense stone hammers recently obtained at St. Peter by Mr. B. M. Randall. One of these was found four feet under ground, and the other was on the surface. They each weigh fifty or sixty pounds. The adjoined sketch of their probable manner of use represents, if correct, probably the most primitive flouring-mill that Minnesota ever possessed. It was prepared by Dr. R. O. Sweeny. While these millstones each have a groove running about them, somewhat on one side of the middle, as if for receiving a withed frame, yet the groove of one appears as if it were of natural origin, and caused by the more rapid disintegration of a vein of micaceous granite or gneiss with which the groove is coincident, while the bulk of the stone is of a firmer rock. In the other, however, the groove has evidently been dug out by coarse artificial chipping.

These *upper millstones* were found at points two miles separate. One, the larger of the two, has the groove deep on one side, but less

*The importance of this "find" caused the writer to distrust his own notes, made in 1872, as to the exact position of the pottery, although taken down on the spot as described by Mr. Van Vorhes, and to make a fresh application to Mr. Van Vorhes for the particulars as to its *exact position*. The following from that gentlemen, who is an experienced surveyor and an exact observer, affirms the position of both as at first stated:

STILLWATER, April 26, 1877.

DEAR SIR:—Yours of the 16th came duly to hand, and found me almost helpless with a rheumatic attack, which explains my seeming neglect to answer your inquiry.

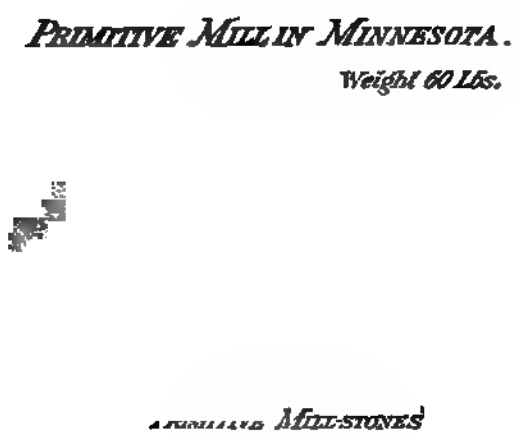
The mastodon tusks were found about eight or ten feet above the base of the hill: the hill at this point rises at an angle of about 45°. After excavating in the base of the hill on the grade of Myrtle street about 37 feet, the tusks were found, consequently 37 feet below the surface. At this point the hill was about 90 feet high.

The crockery I found some thirty feet farther into the hill and some six or eight feet higher in the strata. This hill is a continuous tongue of land lying between the Florence mill stream and a spring run. The two streams run parallel and some 350 feet apart. The hill is so steep on the Florence mill side as to be inaccessible except by clinging to roots and brush growing on it. The material at the base is sand and small gravel. Where the tusks were found the strata were pure sand ten or twelve feet thick, exhibiting clearly the direction of the current in an eastward inclination one or two degrees. On the top of the hill were heavy boulders of the drift period. I deeply regret that indisposition and the weight of eighty-four years have rendered me incapable of composing a satisfactory communication. Yours, with much esteem,

A. VAN VORHES.

iceable on the other, and was found in 1876. It lay "under the und, covered with black earth and sand, above a layer of chalky osit containing some flint and other stones." It was on the ky terrace formed by the Shakopee and Jordan formations near Peter, but a little south of the town, and thirty rods distant n the flood plain of the Minnesota river. The smaller one was nd "two miles further south, just at the foot of the bank, among t of boulders of all sizes." It was found in August, 1874.

FIG. 9.



Primitive flour-mill and outlines of the upper millstones.

mounds that are scattered all over the
as palæolithic, since they pertain to a
st glacial epoch. The mounds are found
els, and in all relations to the drift de-
deposits. Remains that are found em-
lrift, are classed here, according to Mr.
ic. If they are in the gravel or sand
pan of the last glacial epoch they accom-
glacial epoch. If they are in the hardpan
they have a still older date. Under this
is are only those of later date than the

il of Morrison County.

ey is rather sandy, and has reacted against
ity; but the general level of the country,
a very different character. There is a
nuch of the land east of the river, which
date as the loam that is spread over the
outheastern portion of the State, and has
ate a notoriety for ease of culture and fer-
in the United States. This loam in some
It is, indeed, seldom clayey, as it is in
ther places it is wanting, the soil then
or gravelly clay. The eastern portion of
of plain, or rises and falls in broad undu-
occupied by the creeks that generally
l the Mississippi. On the west side of
plains are wide, and are rather wet now,
drained, which can easily be done, when
ess some of the best soils in the county.
underlies these flats sometimes appears in
eady been taken by settlers, as they rise
l furnish a different forest growth; while
es of drift bluffs furnishing heavy hard-
with the bluffs on the east side of the river.
belt of hardpan clay soils, and continue
variations, to the Leaf Hills. Throughout
range, and scattered over the intervening surface, are frequent
ders of granite and of northern limestone.

Water Powers.

There is a fine water-power in the Mississippi at Little Falls, and a rocky island in the river makes its improvement more feasible. This was used at one time for milling and manufacturing purposes, but the dams have been swept out by the river, and the buildings themselves are entirely destroyed. The recent completion of the railroad north and south through the county, running on the east side of the river, is destined to hasten the settlement of this interesting county, and to develop more rapidly its great natural resources.

There are flouring mills already established at the following points:

On the Platte river, Sec. 35, Belle Prairie; three runs of stone, for custom work; also has machinery for cutting lumber. This is known as Grevel's mill.

Hill Brothers' mill is at the mouth of the Little Elk river and manufactures flour and lumber. It has two runs of stone. and 12 feet water head.

V.

THE GEOLOGY OF RAMSEY COUNTY.

Situation and Area.

Ramsey county lies east of the Mississippi and embraces St. Pau the Capital of the State. It contains 101,124.62 acres. It is near rectangular, but is indented on the south by a great northward ben in the Missipi river. On this bend St. Paul is situated. The fo lowing tabulated statistics show the areas of the different town and dates of survey. The territory here described as lying south the Mississippi river was detached from Dakota county and add to Ramsey county by an act of the Legislatnre, approved, Ma 9th, 1874. The county has Hennepin and Anoka on the west, a Anoka on the north. Washington county, about eighteen mi wide separates it from Lake St. Croix, which is the eastern bo

SURVEYING STATISTICS OF RAMSEY COUNTY,

By F. E. Snow.

Township.	Range.	Township Lines.	Township Lines. When Surveyed.	Subdivisions. When Surveyed.	Acres.	Remarks.
28	22	S. & E.	September, 1847	October, 1847	7,785.31	North of Miss. River, Sections 24, 25, 35 and 36 lie in Washington County
28	22	N. & W.	October, 1847			
28	22	S. & W.	July, 1853	September, 1853	2,475.62	South of Miss. River. Includes Sections 4, 5, 6, 7, 8 and 9, except the S. W. ¼ of S. E. ¼ of Section 7
29	22	N. E. S. & W.	October, 1847	November, 1847	22,467.09	
30	22	S. E. & W.	October, 1847	December, 1847	19,270.98	
30	22	N.	August, 1847			
28	23	N. & E.	October, 1847	October, 1847	8,158.17	North of Mississippi River
28	23	E. & S.	July, 1853	August, 1853	168.37	South of Mississippi River, Section 12
29	23	N. E. W. & S.	October, 1847	November, 1847	18,917.87	Sections 6, 7, 18, 19, 30 and 31 of this township lie in Hennepin County
30	23	S. E. & W.	October, 1847	December, 1847	21,881.21	
30	23	N.	August, 1847			
Total area of Ramsey County					101,124.62	

The Surface Features.

With unimportant exceptions the northern third portion of the county is flat while the remainder is rolling or hilly, becoming more and more broken toward the Mississippi river. Thus rolling surface in the southern portion is due to the present *pose* of the drift materials, and not to any upheaval in the rocks. The rocks everywhere lie practically horizontal, but they have been eroded by streams in numerous instances, prior to the drift-epoch, so that there are deep valleys in the rocky surface. These valleys materially modified the manner of deposition of the drift, and determined its composition at special points. The drift materials seem to have been accompanied by more water, in the act of deposit in the level, northern portion, than in the southern, and have also, since their deposit, been smoothed off by the same agency, during the prevalences of a second glacial epoch. The loam that is spread over the most of the county is the sole product, in the most of Ramsey county, of this second glacial epoch, but it was spread by water instead of ice. Where the old drift clay is visible in the northern part of the county it appears as gravelly ridges rising slightly above the flat country round about, and is then but very slightly covered with the loess loam. This loam, however, is conspicuous and abundant over the most of the county, particularly in the eastern portions.

The Mound View Hills, in Mound View township, afford the most important instance of the prevalence of the old hardpan drift above the general flatness of the country in that part of the county. They are in Secs. 10 and 15, T. 30 N. R. 23 W. They rise about 100 feet abruptly above the valleys which separate them, and about 200 feet above Rice creek valley. They consist outwardly of red gravelly hardpan, but they probably have a nucleus of harder rock. Their remoteness from the main belt of the Trenton makes it less likely that their rocky nucleus is of that formation. The Potsdam sandstone, as a quartzyte, rises in monoclinal hills in other parts of the State round the areas of the St. Peter, and forms several such rocky knobs. In this case, if this quartzyte be the cause of these hills, the original rocky knobs served as gathering places for a greater abundance of morainic drift. For further illustrations of similar phenomena in Minnesota the reader is referred to the Second Annual Report p. 193. This series of knolls does not extend far in any direction, their principal elongation being N. and S. There are three principal hills. They are scantily timbered with Burr Oak. The lands about have comparatively but few Burr Oaks.

Natural Drainage.

The most of the county is drained southwardly into the Mississippi. But the streams are small, and expand into lakes at frequent intervals. In the northern part of the county, where the most of these lakes are situated, there is less diversity of surface, and sometimes the streams, and the lakes themselves, are skirted by extensive marshes or "hay meadows." In the northwestern part of the county the natural drainage is toward the northwest, and reaches the Mississppi through Rice creek. The Mississippi river, which runs along the southern boundary of the county, lies in a deep valley which is about two hundred feet below the general upland. The streams which enter it generally pass down this descent gradually at points several miles distant from the river itself. But above Fort Snelling the streams enter it abruptly, by plunging over the perpendicular bluffs of rock, by wbich the river is everywhere enclosed.

The lakes of the county are, some of them, large and deep, and contain pure and clear water. They have low shores, and are but little below the general level in the northern part of the county, but in the southern they are in deep basins in the general surface, having gravelly shores and frequently attractive natural surroundings. White Bear Lake in the northeastern part of the county, and Lake Como, near St. Paul, are the chief of these lakes that serve as summer resorts; though there are several other large, and perhaps equally pleasant, in the central part of the county. Some of these lakes are united by the St. Paul water works, and supply the city of St. Paul, through Lake Phalen, with water for public and domestic purposes. This line of water works, by means mainly of artificial connections, takes its supply from Pleasant Lake, passes through Vadnais Lake (connecting here also with the waters of Bass, Lambert's and Goose lakes), enters Gervais Lake, then Spoon Lake and finally discharges from Phalen Lake through an acqueduct, into St. Paul. Thus an artificial water-course is established from the northern to the southern boundary of the county—Rice lake, the most distant with evident connection, being on the northern boundary, partly within Anoka county.

The water that issues at Fountain Cave, St. Paul, is that of a creek which disappears in the ground about half a mile distant—toward the city.

The knolls themselves are evidently "kames," and in studying the cause all the problems of the glacial epoch are brought before th mind. They are now supposed to have been formed, so far as th drift is concerned, in the beds of streams of water running on and through the ice, and in openings like great crevasses formed by the underlying rocky knobs, as the ice-sheet passed over them. These hills are conspicuous objects in the horizon from distant points in all directions. They are visible from the high land in Reserve township, Sec. 16, T. 28 N. R. 3 W., and from their summits can be seen Anoka, Hamline University, the Reform School, the spires and smokes of Minneapolis, some of the buildings of St. Paul, and the village of Centerville. This view is more extensive, but not so interesting as that on the peninsula on Sec. 16, Reserve, from which point these hills can be seen, and a fine view can be had over the valleys of the Minnesota and Mississippi covering Fort Snelling and Minneapolis at nearer range.

There is another cluster of lower clayey and gravelly ridges in the northwestern part of White Bear Township, and an outlying area of Upper Trenton, causing a high tract in the southern part of the same township.

The southern part of the county, mainly occupied with the Trenton formation, is generally higher than the northern. The drainage courses which pass through it toward the Mississippi lie in deep valleys, which are surrounded and hid by hills and ridges of drift. These hills probably are due primarily to a rock-sculpture older than the drift, but the drift is so thick that the rock seldom appears in exposure above the surface. There is some appearance of the former extension of the valley of Rice Creek much further southward, and it is no unreasonable suggestion that the great Mississippi itself may have once occupied this valley, entering the great gorge again where it becomes remarkably widened at St. Paul; but the evidence is entirely topographical. Such as it is, it is perhaps over-balanced by a confusion of hills and high drift ridges north of St. Paul, which render it improbable that the Trenton is anywhere entirely cut through from the Rice Creek valley to St. Paul, as would have been the case if the Mississippi ever passed through there. Other evidences of this hypothetical position of the Mississippi north of [illegible] l are mentioned under the h Drift.

Description of the Towns of Ramsey County.

28 N. R. 22 W. (*Fractional*) *S. part of* McLean *and part of* St. Paul.

This town shows the extremes between high rolling or hilly land d low alluvial flood plain. The bluff portion east of the Missis-pi is about a mile and a half wide and three miles long, running rth and south, and is cut by east and west valleys and by trib-ary creeks, so as to have a rough or hilly surface. It is consid-ably more than half covered with small timber (oaks and aspens.) e rest of this town east of the river is low, and largely occupied hay meadows or by marsh. A belt of soft timber growing to ge dimensions, separates it from the river channel. On the west e of the river there is a repetition of these features, but in erse order. W. St. Paul is embraced in this portion. Area in msey County 10,260.93 acres.

29 N. R. 22 W. New Canada, *with N. part of* McLean *and N. E. part of* St. Paul.

This town has a rolling or hilly surface, and is about half cov-d with timber. Toward the north it is more flat. Through the tral portion passes the canal of the St. Paul Water Works and alen's Creek. It has several large lakes and also several marshes, t the most of the town is arable agricultural land. Area, 22,-7.09 acres.

T. 30 N. 22 W. White Bear.

This town is mainly flat, and embraces a greater water area than any in the county. It also has several large marshes in the north-ern and central portions. It has a small area of more elevated land in the northwestern corner, east of Pleasant Lake, and another in

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and W. part of St. Paul.

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marshes. Area, 8,326.54

T. 29 N., 23 W. (*Fractional.*) Rose, *and N. W. part of* St. Paul.

The southern part of this town is high and rolling, with a [illegible] clay subsoil. The northern part is more sandy and flat, embracing the portion round Lake Josephine and the southern part of Big Bass Lake. It also contains Lake Como, with a number of other minor lakes, with several marshes. These are mainly in the northern portion. Sections 16, 17, 21 and 22 are mainly of prairie. The rest of the town is well timbered. Area, 18,917.87 acres.

T. 30 N., 23 W. Mound View.

The hills already described, near the center of this town, give it its name. Aside from these hills and a tract along the S. W. corner, the whole town is flat or gently undulating, and has a rather sandy soil. This sand, however, is closely underlain by an impervious clay, as evinced by the numerous lakes and marshes which are found within its limits. Rice Creek is a slow, crooked stream, frequently skirted with marshes or hay meadows. The town is somewhat more than half covered with small oaks, with aspens and elms in the low grounds. Area, 21,881.12 acres.

Elevations in Ramsey County.

	Above the Ocean.
Lowest known water in the Miss. R. at St. Paul	676 feet.
Highest known water in the Miss. R. at St. Paul	697 feet.
Summit between White Bear Lake and St. Paul (8 feet cut), according to the St. Paul and Duluth R. R	959 feet.
Junction at White Bear Lake, St. Paul and Duluth R. R	920 feet.
St. Paul and Pacific Depot, St. Paul	689 feet.
Base of the Capitol, St. Paul	782 feet.
Bluffs back of the Capitol, head of Robert street	901 feet.
Summit avenue bluff	910 feet.
Junction of the St, Paul and Pacific and the St. Paul, Stillwater and Taylor's Falls R. R.'s	762 feet.
Crossing of the St. Paul and Duluth and St. Paul, Stillwater and Taylor's Falls R. R.s	
Grade of St. Paul and Duluth R. R	817 feet.
Grade of St. P., S. & T. F. R. R	797 feet.
Grade of the Mil. & St. P. R. R. at Dayton's Bluff	696 feet.

Soil and Timber.

The southern half of the county has a clayey subsoil, with a clayey lœss-loam overspread; and in general the northern, more flat, portions have the same subsoil, with a sandy lœss-loam over

spread. There are, however, many spots where the lœss-loam is thin or wanting, where the subsoil constitutes also the soil; but in the southern rolling portions this circumstance is likely to afford a clayey soil, while in the northern this clay is more gravelly. Along the Mississippi River is a large area of alluvial land, which is so wet that it cannot be depended on for general farming, but furnishes a great deal of wild hay. There are also some higher flats along the river that are very fine for farming. The county, however, is not generally occupied for farming, but is owned by non-residents.

The following species of trees and shrubs were noted in the examination of the county.

Quercus coccinea. *Wang.* Var. tinctoria. *Bartram.*

[NOTE.—This is the tree that has been named *Quercus rubra L.* with doubt, in former reports. It is what is known oftenest as "Black Oak," but also is called "Quercitron," and "Yellow Barked Oak." Careful observations were made in the survey of this county on this oak. There was a specially favorable opportunity in West St. Paul, where were seen evidently two species, of oak, the black and the red, yet nearly alike, growing in a ravine in the same situation. This was near the "Farmer's Hotel" on the E. side of the street. They were here in company with white oak. The two species here growing under the same circumstances showed constant differences. Several trees here, of each. are of about the same size, but small. The general habit and color of the two are the same, except that the red is more open-branched, and looser in the top, having fewer dead twigs and branches. The chief distinctions are in the leaf and fruit. The red-oak leaf has the same general shape, and the same number of toothed lobes as the black, but the central undivided portion is wider than in the black, and the whole leaf is longer in proportion to its full width; hence its foliage is coarser and heavier than in the black. The leaves of the red droop, while those of the black turn easily with the wind, and stand in all positions. In the fruit, the acorn of the red is double the size of that of the black, both growing on last year's wood; the acorn of the red rising three or more times the hight of the shallow cup, while that of the black only rises about twice the hight of the cup. The cup of the red is generally an inch across; that of the black about half an inch or a little more.

This is by far the most abundant oak in the county, as it is throughout the southern half of the State; but there are some situations, particularly exposed, high hillsides, like the tops of Mound View Hills, in which it is noticed to fail, though growing abundantly

on lower levels, and to be replaced by the Bur Oak. It does not frequently appear as a large tree, but is generally less than ten inches in diameter, or simply has the size of shrubs, intermixed with Bur Oaks of the same size.]

Quercus rubra. *L.* Red oak.

[NOTE.—At present this oak must be restricted to the only point at which it has been identified, *viz.* West St. Paul.

Quercus macrocarpa. *Michx.* Bur Oak.
Quercus alba. *L.* White Oak.
Ulmus Americana. *L.* (Pl. Clayt.) Willd. American Elm.
Populus tremuloides. *Michx.* Aspen.
Populus grandidentata. *Michx.* Great-toothed Poplar.
Populus monilifera, *Ait.* Cottonwood.
Tilia Americana. *L.* Bass.
Negundo aceroides. *Mœnch.* Box Alder.
Juglans cinerea. *L.* Butternut.
Carya amara. *Nutt.* Bitternut.
Fraxinus Americana. *L.* White Ash.
Fraxinus sambucifolia. *Lam.* Black Ash.
Acer rubrum. *L.* Red Maple.
Acer saccharinum. *Wang.* Sugar Maple.
Betula alba. *Var.* populifolia. *Spach.* (?) White Birch.

[NOTE.—About some of the lakes becomes 12 and 14 in. in diameter.]

Larix Americana. *Michx.* Tamarack.
Juniperus Virginiana. *L.* Red Cedar.

[NOTE.—Large trees grow at Lake Johannah, and also along the rocky bluffs of the Mississippi.]

Salix nigra. *Marshall.* (?) (And other willows).
Ulmus fulva. *Michx.* Slippery Elm.
Prunus serotina. *Ehr.* Black Cherry.
Pinus Strobus. *L.* White Pine.

[Only along the banks of the Mississippi above Fort Snelling.]

Betula excelsa, *of American authors.* Gray Birch.

[At Lake Johannah.]

Prunus Pennsylvanica. *L.* Small Red Cherry.
Prunus Americana, *Marsh.* Wild Plum.
Zanthoxylum Americanum. *Mill.* Prickly Ash.

Ostrya Virginica. *Willd.* Ironwood.
Carpinus Americana. *Michx.* Water Beech.
Prunus Virginiana. *L.* Choke Cherry.
Amelanchier Canadensis. *Torr and Gray.* Juneberry.
Pyrus coronaria. *L.* American Crab Apple.
Rubus occidentalis. *L.* Black-Cap Raspberry.
Rubus strigosus. *Michx.* Red Raspberry.
Rubus villosus. *Ait.* High Blackberry.
Ribes Cynosbati. *L.* Wild Gooseberry.
Ribes rotundifolium. *Michx.* Smooth Wild Gooseberry.
Ribes lacustre. *Poir.* (?) Swamp Gooseberry.

[Has a smooth fruit in racemes.]

Sambucus Canadenses. *L.* Elderberry.
Spiræa opulifolia. *L.* Ninebark.
Spiræa salicifolia. *L.* Meadowsweet.
Celtis occidentalis. *L.* Hackberry.
Alnus incana. *Willd.* Speckled Alder.
Alnus serrulata. *Ait.* Smooth Alder.

[NOTE.—Both alders are found, often in company, on the flats about White Bear Lake, but the smooth rarely exceeds three feet in hight, the other being ten or fifteen.]

Amorpha canesceus. *Nutt* Lead Plant.
Amorpha fruticoso. *L.* False Indigo.

[This has very much the appearance of a small locust.]

Aristolochia Sipho. *L'Her.* (?) Pipe Vine.
Rhus glabra. *L.* Smooth Sumac.
Rhus typhina. *L.* Staghorn Sumac.
Rhus Toxicodendron. *L.* Poison Ivy. (Tuttle Lake.)
Vitis cordifolia. *Michx.* Frost Grape.
Symphoricarpus occidentalis. *R. Br.* Wolfberry.
Corylus Americana. *Walt.* Hazel.
Cornus florida. *L.* Flowering Dogwood.
Cornus sericea. *L.* Silky Cornel.
Cornus alternifolia. *L.* Alternate-leaved Cornel.
Cornus paniculata. *L'Her.* Panicled Cornel.
Ceanothus Americanus. *L.* Jersey Tea.
Vaccinium corymbosum. *L.* *Var.* amœnum. Swamp Blueberry.
Lonicera parviflora. *Lam.* Small Honeysuckle.
Celastrus scandens. *L.* Bittersweet.
Ampelopsis quinquefolia. *Michx.* Virginia Creeper.
Rosa blanda. *Ait.* Early Wild Rose.
Viburnum Opulus. *L.* Highbush Cranberry.
Cornus stolonifera. *Michx.* Red-osier Dogwood.
Cratægus coccinea. *L.* Thornapple.

The St. Peter Sandstone.

This sandstone is seen in the bluffs of the Mississippi from Fort Snelling to the southeastern corner of the county; and by reason of the breaking down of the overlying Trenton wherever former drainage streams have run, and the easy erosion of this rock, it also becomes the surface rock in a number of tributary valleys. In the city of St. Paul there is a large expansion of the St. Peter area over the low level through which Phalen's creek, and others, enter the Mississippi, which extends more than a mile north of the river. Further south are several such re-entrant areas in McLean township. The wide bottom-land east of the river, in McLean township, is represented on the geological map of the county, as St. Peter, but it is possible that the Shakopee limestone, which is shown at Red Rock, some further south, extends as the surface rock within Ramsey county, under the alluvium of the floodplain, but it is nowhere visible. At the most it can occupy but a small area. The St. Peter is about 150 feet thick. It has no noteworthy variations of character, as far as seen in Ramsey county, and it has already been described so many times that its lithological features need not be delineated again.

The Lower Trenton.

This is what Dr. Owen styled "St. Peter's Limestone," in his final report on the Geology of Wisconsin, Iowa and Minnesota, and which Dr. B. F. Shumard divided into:—

1. Upper Shell limestone.	F. 3. c	6 ft.
2. Non-fossiliferous Bed.	F. 3. b	5 ft.
3. Lower Shell limestone.	F. 3. a	23 ft.

In later reports, particularly those of the Wisconsin geologists, they were designated as the "Buff Limestone," and the "Blue Limestone," the former lying below the latter. These terms, however were strictly applicable only to formations in Wisconsin, but by inference were extended to cover the geological horizon at St. Paul and the Falls of St. Anthony. The Blue Limestone, however, of northern Wisconsin seems to have been regarded by Dr. Lapham as the equivalent of the Hudson River Group, of New York, and also of a formation of the same name in Ohio, where the term originated, and supposed to lie entirely above the proper Trenton.* These

* When this term was originally applied to the Ohio rocks they were regarded as a continuation of the Trenton limestone of New York.

terms seem still the more inapplicable to the limestones seen at St. Paul and St. Anthony Falls, since the terms "buff" and "blue" should be in reverse order. The "Lower Shell limestone" is more frequently blue than the Upper Shell limestone, and is always so on fresh quarrying. The latter is rather a dirty gray or drab, appearing somewhat like a fine-grained sandstone, and is often harsh to the touch.

Later still the whole of the limestone exposed at St. Paul was classed by Prof. James Hall as the equivalent of the Wisconsin "Buff Limestone," the "blue limestone" being some higher member not distinctly recognized in Central Minnesota, but in the light of further observations now known to be what has been designated by this survey as the "Upper Trenton," at its chief exposures in the southern part of the state, but which has not until the present been discovered as far north as St. Paul. At the same time (Geology of Wisconsin, Vol. I, p. 33.—1862.) Prof. Hall regards the Buff Limestone as the equivalent of the New York "Birdseye" and "Black River" limestone. In the meantime, the "Blue Limestone" in Ohio has become enlarged into the "Cincinnati Group," and the Trenton in that state involved so closely with it that its identity is nearly or wholly lost. On the west of the Mississippi, however, the Trenton has been shown to have a full development, and even to take on a peculiar phase designated "Galena," while the aluminous phase so largely developed at Cincinnati has only been recognized in the "Maquoketa Shales" of Dr. White.

Still more recently Prof. Chamberlain, of the Wisconsin survey, has shown (Geology of Wisconsin. Vol. II, 1873-77) that the lithological differences commonly relied on to distinguish the "blue" from the "buff" are not general nor reliable; that there is no chemical distinction which holds good, and that the fossils of the "buff," as heretofore limited, are also to be found above the "blue." Hence he regards them as essentially one. Further, in the northern part of the State he states that even the *Cincinnati Shales and Limestones* are undistinguishable by any satisfactory line of demarkation from the Trenton limestone, and includes that with the rest, under the general term "Trenton Group."

With these preliminary remarks it will be understood that the term *Lower Trenton* is not supposed to convey any greater significance than an appropriate designation for a local lithological phase, by which the lower part of the great Trenton Group is easily distinguished from the rest in the state of Minnesota.

Wherever the base of the Trenton has been seen in Minnesota, it has been found to consist of about 25 feet of calcareous firm

beds (sometimes with some shaly layers), which give great prominence to this geological horizon in the topographical effects which they produce. They are underlain by an erosible sandrock, and overlain by a varying thickness of green shale. The underlying sandrock crumbles away, letting the limerock project, but the overlying shale sheds the surface waters that would otherwise disintegrate the limerock. These combine to preserve the limerock and to cause it to project in long, prominent headlands, and to form the brows of ridges and terraces which diversify several counties in the southeastern part of the state. The thickness of the overlying shale has heretofore not been supposed to exceed twenty feet, but observations made in Ramsey county go to show that the whole upper Trenton, so called in the southern part of the state, is here changed to a calcareous shale, with thin limestone layers, perfectly comparable to the Cincinnati shales and limestone of Ohio.

In Ramsey county this lower Trenton, or "Buff" limestone, as Dr. Owen at first designated it, is separable into three parts which have pretty constant characters, and they are approximately as given above from Dr. Shumard.

1. Impure, harsh, drab or dirty buff limestone, containing lumps of calcite and species of *Strophomena* and *Orthis*, with other fossils..........	6–10 feet.
2. Shale, and calcareous shale with fragments of fossils.....	6–10 feet.
3. Limestone, with aluminous partings. This is the building stone of St. Paul. The mingling of shaly and calcareous parts throughout this limestone causes the dressed surfaces of large slabs to have a blotched or mottled surface, particularly when the dressed side coincides with the natural bedding. This member is the most persistent of the Lower Trenton, but splits into thin layers on long exposure, due to the loosening of the shale throughout the mass. This contains fossils characteristic of the Trenton, but generally in fragmentary condition...............	15 feet.

Besides the three main parts above described there are also several thin beds of green shale in No. 1, which seem not to be confined to any definite horizon, and nearly always a layer of green shale below No. 3.

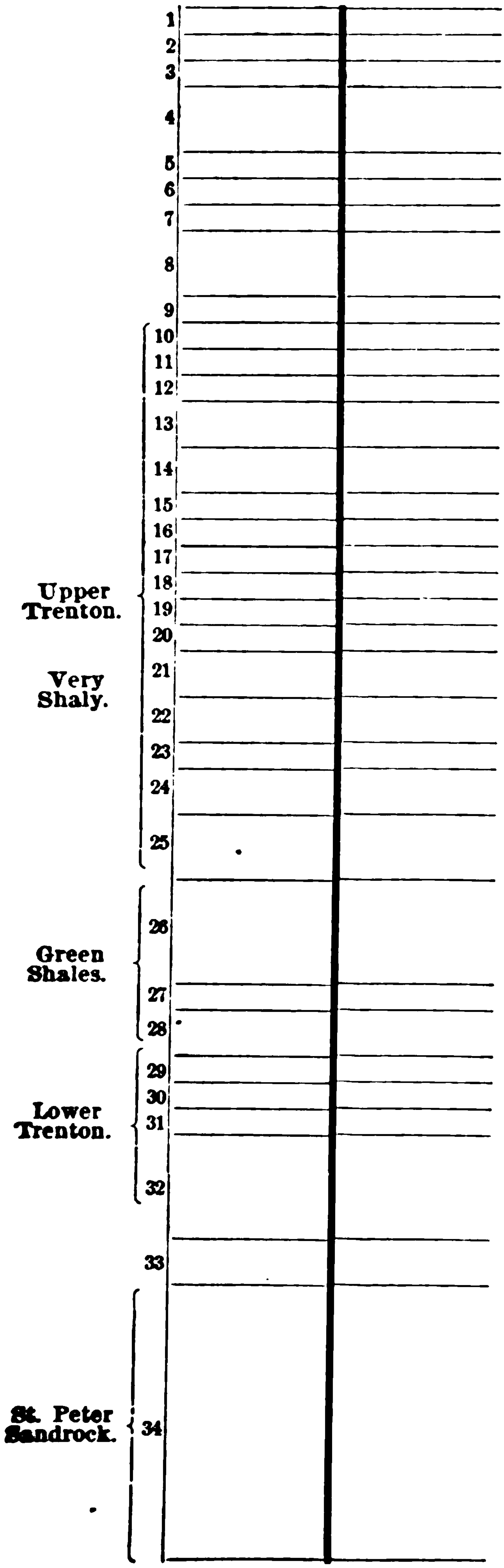
In sections of the bluffs at St. Paul given in Dr. Owen's final report, this limestone is represented as greatly broken and even faulted along the river from Fort Snelling to St. Paul and especially in the vicinity of New Cave (now known as Fountain Cave) near the railroad bridge of the Milwaukee and St. Paul R.R. This locality was specially examined. The layers of the limerock are, it is true, disturbed along the immediate river bluff and are mixed in some

confusion with coarse drift, but at points further from the river the beds continue along horizontal and unbroken, so that the formation itself cannot be said to be disturbed. Dr. Owen attributes rightly this broken condition, so far as the blocks seem to lie on drift materials, to the action of water, and probably that of the river at some higher stage. The beds were undermined and dislodged, but were not transported. Probably floating masses of ice, during the last glacial epoch which did not extend as a continuous ice-sheet east of this place, in Minnesota, played an important part in displacing these limestone blocks, and in depositing among them the water-worn drift.

The Green Shales and Upper Trenton.

The first intimation of the existence of any rock *in situ* in Ramsey county, above the Green Shales as they have been described in counties further south, and in Hennepin county, was found in the drilling of the well at the State Reform School near St. Paul. This was ordered by the legislature of 1877, and was done by C. E. Whelpley of Minneapolis. Mr. F. McCormick, Secretary of the State Reform School has furnished the following:

Notes of the Deep Well Bored at the State Reform School, in the Months of April and May, 1877.



	Feet.
1. Two feet black soil	2
2. Three feet gravel	3
3. Six inches clay	0½
4. Thirteen feet coarse gravel	13
5. One foot fine sand	1
6. One foot coarse gravel	1
7. One foot fine sand	1
8. Thirteen feet coarse sand	13
9. Two feet boulders	2
10. Three inches lime rock	0¼
11. Three feet clay	3
12. Two feet sand, with water	2
13. Six feet three inches shell rock with clay	6¼
14. Seven feet hard lime rock	7
15. Two feet clay	2
16. One foot hard rock	1
17. Four feet blue clay	4
18. Four feet hard rock	4
19. One foot blue clay	1
20. Three feet lime rock	3
21. Six feet clay, light color	6
22. Five feet clay, dark color	5
23. Four feet yellow clay	4
24. Five feet blue clay	5
25. Eight feet blue clay (very hard)	8
26. Twenty-eight feet blue clay	28
27. One foot lime stone (hard)	1
28. Six feet blue soap stone	6
29. Three feet lime rock	3
30. Three and one-half feet blue soap stone	3½
31. One and one-half feet lime rock	1½
32. Twenty-eight and one-half feet blue lime stone	28½
33. Five feet blue clay	5
34. Seventy-seven and one-half feet white sand rock	77½
Whole depth	252

An abundant supply of water was obtained at the depth of 150 feet. This supply, however, was not tested until after the well had been bored one hundred feet below it. The drill at that point, became fixed and immovable so that the contractor was wholly unable to proceed further, when, after experimenting with pumps, it was found that the supply was sufficient for all practical purposes.

The water was obtained after drilling about ten feet in the lime rock of No. 32.

From this source the water rose in the well about eighty feet. The water is supposed to be of excellent quality.

Of these, No. 34 is plainly the St. Peter sandstone. No. 33 is the green shale which is nearly always seen over the sandstone in Hennepin and Ramsey counties. Nos. 32 to 29, inclusive, include the Lower Trenton, but the thickness seems greater than elsewhere observed, being 36½ feet. The rest of the drill seems to be taken up with alternating shale and limestone layers, the greater portion being of shale. Of this thickness (101½ feet) probably the main mass of shale, near the bottom, said to have been 28½ feet thick, represents the green shales that had before been identified; but there is not sufficient difference between this and the rest to exclude the application of the same term to the whole of the beds above No. 29.

A few months later an exposure of green shale was seen in the road, N. W. ¼ Sec. 9, in Reserve, accompanied by *Chætetes* and *Orthis*, above the level at which the regular green shale could exist. Blocks of fossiliferous blue limestone were also seen abundantly along a ravine in the same township, (Sec. 15) mixed with the debris of the red hardpan clay, far above the level of the Lower Trenton; a circumstance at variance with any thing before seen in Ramsey county. Finally, the beds in place were found in a good exposure along Ramsey street in St. Paul, where it ascends St. Anthony Hill. They were first seen in a little artificial ravine made for a watering tank. They are exposed in a similar manner in other ravines that descend St. Anthony Hill toward the river, farther west. The basis rock of St. Anthony Hill is the same. Their thickness above the Lower Trenton is 108 feet, and they have a conspicuous strike, as already stated, in a line of drift-covered bluffs that run from St. Paul northwestwardly, reaching Anoka county south of Rice creek, causing the high and hilly land there seen. These beds also form the nucleus of the high land that extends from St. Anthony Hill southwestwardly toward Fort Snelling, distant about three-fourths of a mile from the river.

These beds are very shaly, not more than one-third of the whole being limerock, and contain the usual fossils of the Lower Trenton, but their paleontology has not yet been examined carefully. The whole formation seems to have the characters of the Cincinnati, as exposed in Green Bay, Wisconsin, or in Ohio.

The Trenton Group.

In New York the Trenton limestone is succeeded by a mass of shales with the local designations, Utica slate, Frankfort slate, Shales and sandstones of Pulaski, and Lorraine shales. These were all em-

braced in the term Hudson River Group, which had before been applied to a mass of shales that are now known to be much lower. On account of this error the term Cincinnati Group has been generally substituted.

On the other hand in Iowa and southern Wisconsin and Minnesota, the Trenton limestone is found to pass into the Galena by slow stages and to be followed, at least in Iowa, by a greatly reduced representative of the Cincinnati Group, named by Dr. White the Maquoketa shales. Leaving Iowa and passing into Minnesota the Trenton limestone increases in thickness, and the Galena diminishes, the latter becoming interstratified with beds of shale. In Olmsted county, still further north, the Trenton also contains numerous beds of shale and the Galena is still further reduced. The beds are traceable by continuous or frequent outcrops throughout Goodhue and Rice counties, with an increasing amount of contained shale in the Trenton, and finally with the total loss of the Galena. On account of the soft and shaly nature of the upper beds, by the time they reach Ramsey county they are so covered with the greater drift accumulations that their presence so far north had not before been suspected. Here is an ascertained horizontal change in the character of the beds of this formation, between the southern and central portions of Minnesota, which brings up the question as to the designation they should bear at St. Paul. They are the horizontal equivalents of what has been recognized as the Trenton formation in the southern part of the State, and in neighboring States, and contain the same fossils; but they have the lithological character and the geological position of another well organized group of rocks in Ohio and northern Wisconsin. The eastern Cincinnati fossils are also the western Trenton fossils. Here we have two equally well established names for the same series of beds.

The cause of this gradual change in the formation from dolomitic limestone to a pure limestone, and then to an argillaceous limestone, and at last to a mass of calcareous shales, is to be sought for in the character of the ocean's bed, and the nature of the water and its currents, in the Silurian ocean. And here it is only necessary to apply a well known law of ocean sedimentation, viz.: *the nearer the shore the shallower the water, and the coarser the sediment.* This seems to make dolomitic limestones in the deepest waters, ordinary limestone in deep water, and shales and sandstones in shoal water. The strike of the formation under consideration passes through all these conditions and directly toward the metamorphic area of the State which lies but little further north. Hence, at St. Paul the water was much shallower than at Rochester, and the sedimentation was much coarser; while at Rochester there was much more shaly sediment than at Dubuque. The direction of the strike of these rocks in New York State is along the shore-line of the ancient ocean, and hence the opportunity for noting this change was much less favorable. In Wisconsin and Minnesota the strike is north and south, and in Minnesota rapidly approaches the ancient shore-line.

The Drift.

While the county is wholly covered with a red hardpan clay, believed to be of the age of the first glacial epoch, it shows some variations that require special mention, and is also furnished with a lake deposit which forms the surface soil.

At St. Paul the red hardpan is found uniformly in excavating for buildings in all that low area about the levee, and in the deep cuts through the gravelly bluff north of E. Third street. Although here it is covered with sometimes more than forty feet of lighter-colored drift materials, it emerges from under these immediately on getting outside the valley either north or south, and is covered, but sometimes thinly, with the loess loam. This overlying loose drift is found along the Mississippi valley throughout the county, and everywhere shows the action of water in its deposit. It very seldom contains any clay, and when it does the clay is stony and has a different color from the red hardpan clay. Above Fort Snelling, and in the western part of Reserve and Rose townships, the red hardpan has not the same clayey and unmodified character that it has in the eastern part of the county. It seems to have been washed by water, and in that manner to have lost some of its clay, while there are localities where materials of a different color, particularly gravelly deposits, are superimposed or mixed with it, so that sections seen along the western part of University Avenue have a confused arrangement and mingling of the coarse water-worn materials of both the red hardpan and the gray, with occasional patches of gray hardpan. This water-washed condition also prevails in the low gravelly knolls and ridges that are seen occasionally in the northern flat part of the county, but without any intermixture of materials referable to the gray hardpan. In the high and rolling tract occupied by the Upper Trenton, this red hardpan shows to the best advantage, whether in the western or eastern part of the county. In the deep excavations made in St. Paul this red hardpan is seen to be overlain by a fine red laminated clay, which is probably of the same nature and origin as the so-called *Tripoli* found at Stillwater, the thickness of which sometimes reaches six or eight feet, but which in some places is entirely wanting. This seems to be related to the underlying hardpan sheet somewhat as the laminated brick clays and loams of later date are to the gray hardpan which they overlie, and was deposited during the waning period of the former glacial epoch, and when water was abundant but comparatively quiet.

What has now been described, *i. e.* the red hardpan and the red laminated clay overlying it, were the products of a glacial epoch which brought its materials from the north and northeast, the red color being due to the prevalence of the debris of red sandstone, shale, and other iron-charged rocks that are developed largely in the vicinity of Lake Superior. Whether this ice-period preceded or followed the excavation of the immense gorge of the Mississippi which is visible southward from Dayton's Bluff in St. Paul, is not ascertained by any observed facts, but several considerations would require a date subsequent to that excavation—or to the greater portion of it. It is probable the Mississippi began to excavate that gorge at the time of the elevation that brought the upper Trenton (or the Cincinnati) above the Silurian ocean, an event which has been taken to divide the Silurian in America into two parts, the upper and the lower. In that case it is the oldest portion of the Mississippi gorge at present known, and has since that event carried off the waters of the Metamorphic land areas of Wisconsin and Minnesota. The St. Croix valley seems to be equally old, and perhaps served for the drainage mainly of the Wisconsin area, while this carried only the waters of the Minnesota area, the two uniting then, as now, at or near Hastings. The sculpturing of the rocks into canyons in the western portion of Wisconsin, and their uniform trend southwestwardly show they must always have reached either the ocean or a great river, lying in that direction. Isolated areas of the Trenton in northwestern Wisconsin, as well as in central Minnesota, left to the present without destruction, though surrounded by larger areas of older formations deeply cut by the same forces into gorges and wide valleys, point directly to the close of the Lower Silurian as the starting point of the history of this part of the Mississippi valley. The rest of the valley-gorge, even to the Gulf of Mexico, being composed of much later formations, must have been unformed, even buried in the slowly accumulating sediments of the ocean for many ages later. If some portions of it are wider, or deeper, than this, it is due to greater volume of water, and to softer rocks, not to greater age. It is probable, then, that the advent of the first glacial period did not divert the Mississippi river from its channel below St. Paul. But the valley is much narrower above St. Paul than it is below, and this continues indefinitely southwestwardly by way of the Minnesota valley. This is very noticeable on examining the geological map accompanying this report. There is also a significant change in the direction, and one the more significant as it seems not to have been due to any rock formation existing at St. Paul, but directly

contrary to the rock sculpturing that exists there favorable to the continuance of the river in any preoccupied valley running in the same direction. Allusion has been made to a possible ancient gorge through the Trenton north of St. Paul in describing the surface features of the county, but in the geological map of the county no such gorge is represented, because it never has actually been discovered, and its hypothetical location would perhaps be of no service.

These anomalous and significant facts can all be reasonably explained on the supposition that the Mississippi river was diverted from its ancient valley-gorge, north of St. Paul by the ice and drift of the first glacial epoch, and that it was driven into that which has been described in the report on Hennepin county, toward the west further, and joined the Minnesota valley at some point above Fort Snelling, but between that point and Shakopee, without passing over or through the Trenton limestone at all. Their united waters then formed the river which excavated the gorge between Fort Snelling and St. Paul (unless the Minnesota alone had already done it) between the first and second glacial epochs.

When the second glacial epoch came on, the country must have been more or less covered with constant or periodical ice sheets for many miles south of the line limiting actual glacier movement. These minor local and seasonal ice-areas produced their subordinate effects, but so similar to those of the great moving glacier itself that it is rendered very difficult, except with the aid of certain marked differences in the nature of the transported material, or some fortunate topographical or other evidence, to define the area of the second great glacier as compared with that of the first. These local ice-areas, which could not have had much movement as ice, served to disturb the surface of the old drift, and, by the water they afforded on breaking up periodically, to carry away the clayey parts, and to mix superficially the materials of the new drift with the old. At points, like that of Hennepin and Ramsey counties, where a great river course co-operates to mix these materials, we would necessarily see the new extending farthest over the old, and even the effects of ice in large masses extending down the valleys further than on the uplands.

In Hennepin county, and generally over the northwestern part of the State, are evidences that the ice of the second glacial epoch moved rather from the northwest than from the northeast. (See Hennepin county report, 1876.) The washed surface of the old drift, and the area of the loess-loam, both indicate that Ramsey county and the southeastern part of Hennepin were not disturbed

generally by the glacial ice of this epoch. The disturbance, however, was sufficient to choke up again the Mississippi river, and at the mouth of Bassett's creek in Minneapolis, to drive it to the east, as fully detailed in the report on Hennepin county, thus bringing it into the channel that it now occupies between Bassett's creek and Fort Snelling.

The drift of the second glacial epoch is found as a stony clay in few places in Ramsey county. In some of the excavations at St. Paul, in the lower portions of the city, a gray hardpan is found, and there may be a considerable of it even under the water of the river itself, filling a deep gorge, but it lies over the red hardpan when that also is present. The disintegration and wash from the shales of the Upper Trenton seems also to have mixed with the drift at St. Paul so abundantly as to produce a stony gray clay which is hardly distinguishable from the true glacial clay. Some parts of Reserve township also show patches of the gray hardpan, rather mixed with than overlying the red.

As a gravel or course sand, the product of the second glacial epoch is much more abundant in Ramsey county. The gray gravel and sand, with the washed limestone pieces and boulders composing the bluffs and hills that have been so much excavated for streets at St. Paul, are the modified product of the second glacial epoch, modified at the time of their origin and deposition by the water resulting from the disintegrating margin of the glacier (perhaps here feebly extended to this point) but augmented by the co-operation of the natural waters of the Mississippi, then swollen to great dimensions. The same deposit, but much less abundant, produced by the same agency (except the presence of the Mississippi) is spread over much of Reserve or Rose townships, and has already been alluded to as the indirect effect of the second glacial epoch over the pre-existing drift surfaces.

Occasional pieces of northern limestone are found in the drift ridges and knolls about Mudhole and Fitzhugh and Gervais lakes, and two pieces of native copper were found on the south side of White Bear lake, near the Ramsey county line. Indistinct glacial marks in West St. Paul, under the red hardpan, run W. N. W.; but this was an unsatisfactory observation.

The Loess Loam.

That this deposit is the result of widespread diffusion of fresh water, at the time of the last glacial epoch, over those surfaces either drift-covered or not, which were not at the time affected by

the glacier movement, is highly probable; but what the peculiar circumstances and causes of such gentle diffusion of nearly tranquil waters were, it is not yet possible satisfactorily to detail. The loess loam is found in all parts of Ramsey county, but it varies in thickness and in composition. It is thin or wholly wanting in some rolling gravelly tracts, and is very thick in some confined valleys. It is sandy, or graduates downward into sand, in much of the northern part of the county, particularly in Rice Creek valley, and in some places in the bluffs of the Mississippi below St. Paul, and it is fine and somewhat clayey in the high and rolling clay tract in the eastern part of the county, particularly in the eastern part of New Canada. It forms a very fine soil for farm crops. It covers the boulders and gravelly clay of the real drift. It fills some old valleys —indeed is always thicker in valleys than on the uplands. It is occasionally stratified and passes into sand below in places where agitated water was abundant enough to have moved such materials before the epoch of the loam. In other cases it is placed abruptly immediately over a coarse, gravelly or boulder-bearing stratum.

In the southwestern corner of the state (Rock and Pipestone counties) there is a gradual change from stony boulder-clay to the loess loam, horizontally, in passing from the Coteau de Prairie (in Lyon and Murray counties) southward to the Iowa state line. Exposures along the banks of creeks, and the digging of wells, make this plain. There is a gradual loss of boulders, then of the small stones, then of gravel; and an equally gradual increase of the characteristic features of the loess-loam,—close, clayey consistency, crumbling in the air like slacking quicklime, and white limy concretions. In some cases the concretions, which have been so often mentioned as a peculiarity of the loess-loam, are in the same deposit with small gravel stones of northern origin; and pieces of northern limestone. The drift clay, true northern boulder clay, the product of glaciers, thus changes gradually into a true loess-loam, the product of aqueous agencies. While this indicates for that locality, at least, a merging of one force into the other, and the slowness of the change, through an interval of about 50 miles in a broad, level, open country, it perhaps gives the key to the events that occurred in other latitudes where the surface was more broken, and where the effects are more complicated by not having all the steps recorded. Just as in the older geological formations, wherever the series is complete, without sudden transitions, the history is best known, so in the history of the drift, where the effects change gradually, are the records of "lost" epochs, and these "beds of transition" need the closest scrutiny, being the only evidence of what transpired

between formations which in other regions pass abruptly from one to the other. This here indicates that the age of the loess-loam was cotemporary with that of the boulder clay in the Coteau de Prairie. There must be some explanation given for the co-existence of these forces which spread the loam and those which brought the glacial drift. In other words, if the loam, which is sometimes a laminated clay, be regarded as the equivalent in age of the fine laminated clays of the great lakes and of other high-water marks in the northwest, which have been referred to a distinct "epoch" by Dana and others (the Champlain), then that epoch was not subsequent in time to the glacial epoch but cotemporary with it, and its phenomena differ from those of the last glacial epoch because they have been studied at distant points where they are contrasted, and where the glacial winter operated differently. Where there is an immediate succession of superposition, that fact in the drift does not imply immediate succession in time any more than it does in the Silurian rocks, a fact which has been ignored many times; and hence have resulted a great many special histories and theories. The loess-loam, for instance, lies on the older drift clay all along the Mississippi valley, and has generally been taken to prove an immediate transition from the drift-epoch to the loam-epoch, when really a long period of time, involving forest growths and the slow on-coming of a glacial epoch, intervened, the loam itself passing horizontally into the glacial deposits of that epoch.

So in Ramsey county the loam has been seen to follow by insensible gradations from a sand or even a fine gravel, the change here taking place perpendicularly. In this case the coarser deposit below was the result of more copious and more agitated water, as in the bluff-terraces below St. Paul, or in the washed materials in the western part of Reserve township, and the loam the result of the diminution and more quiet state of the same waters. Thus, if the waters which overspread and washed the old drift and formed the gravelly terraces of the Mississippi came from the ice-fields of a contemporary glacier lying further north, then the waters which spread the loam, a finer deposit, also came from the same source, operating a little later, and with diminished force.

Wells in Ramsey County.

Good water for all household purposes is obtained in Ramsey county with little effort, in shallow wells that seldom pass through the drift, the majority of them being less than twenty-five feet deep. Throughout the northern portion of the county water is generally

found in sand, or below a sandy loam, which also rises to the surface forming the soil and subsoil. The underlying clay is seldom penetrated to any great depth. But in the southern portion wells more frequently are deeper, and obtain water in gravel after passing through not only the surface loam but also a greater or less amount of red clay.

Material Resources—Timber.

The county is generally clothed with a scant forest growth, but the trees are small. There is not much timber of any sort suitable for lumber, and it is not much cut for fuel. Farmers cut some and haul it to St. Paul, but the wood fuel of St. Paul is very largely supplied from the "Big Woods," west of the Mississippi river.

The county has generally a good soil, the most of which still lies in its primeval condition. So far as the natural resources of the county are concerned, they lie in its soil to a greater extent than in any thing else.

Building Stone.

The stratum of the Lower Trenton used at St. Paul is the same as at Minneapolis, and furnishes a stone similar in all respects. The stone for the piers of the bridge over the Mississippi was taken out in West St. Paul, but about half a mile above the bridge.

The quarries in West St. Paul are in the public street, and are worked by Adam Rowe.

On the other side of the river, Mr. Sigler has quarries in operation on Stewart Avenue, near Leech street. The most important quarries in St. Paul are near the State Capitol, but there are a great many other small openings in different parts of the city.

Although this formation has been used in the majority of the stone buildings in St. Paul, and makes a fine appearance, yet its tendency to disintegrate has caused it to be less regarded, and has led to the introduction of other building stone. The U. S. Custom House is built of Sauk Rapids granite, and the Baptist Church of the Shakopee limestone quarried at Kasota.

Along the south side of White Bear lake, Sec. 32, Grant, Washington county, are exposures of the Trenton, some of which have been opened by Messrs. Walter and Weaver. Another is on the land of Mr. Huffman on Sec. 30, nearer the lake, in the bluffs facing northeast; and still others are further south and east. There is every reason for expecting as good building stone here as at St. Paul, except that the beds would naturally be a little more shaly,

being situated nearer the ancient shore line when the deposit was forming, and for the same reason that makes the Trenton at St. Paul more shaly than at Faribault. These exposures, however, have not been much worked, and do not seem to be generally known.

Mills and Water-Powers.

The *St. Paul Mills*, St. Paul, are owned by Henry Shaber, and are on Phalen's creek. They have three run of stone for flour and one for feed. Have 20 feet fall of water, and turbine wheel. Only grind for custom use.

The *Brainerd Mills*, (Thau and Ham), have three runs for flour and one for feed, and are also in Phalen's creek, with 30 feet fall and turbine; custom and shipping.

The *City Mills*, (Lownsman, owner) St. Paul, have two runs of stone for flour, and 19 feet fall; custom only.

The *North Star Mills* are also at St. Paul, and have three runs of stone for custom work, and 19 feet fall, owned by Protz and Braun.

The *Union Mills* are owned by W. Lindeke, with four run of stone, and 20 feet fall, situated at St. Paul.

The last three above are run by overshot water-wheels.

The *Reserve Mill* are on the Fort Snelling road, at St. Paul, and are only calculated for grinding feed; have two runs of stone and 20 or 21 feet fall; owned by — Cunrad. These mills used to do flouring.

Brick in Ramsey County.

John Jæger, St. Paul, on Dayton's bluff, makes red brick from the loess loam.

Graham & Co., W. St. Paul, make red brick from clay taken from the alluvium of the flood plain. This yard, however, is now inactive, and is owned by John Jæger.

Section 32, White Bear. Formerly a good red brick was manufactured at a point between the railroad and the lake shore (Vadnais lake), from the surface loam that here covers the country, but as the owners were not much patronized, owing to the general financial depression which retarded all building, the yard was closed, and remains so.

The brick clay which is seen in the bluffs at St. Paul, in the excavations made for street purposes on Fifth street, between Sibley and Wacouta, lies between deposits of coarse gravel and stones, all water-washed. This clay, which is probably the near equivalent in age and nature of the brick clay so extensively used for brick at Minneapolis and Carver, has not been thus employed at St. Paul.

Earthworks.

On Dayton's Bluff are several large mounds, one being about six feet high and 30 or 40 feet across.

At White Bear Lake is a large artificial mound, about 12 feet high and 35 or 40 feet across. It is close to the shore of the lake, within the village, on lot 2, on the road to Goose Lake.

In Dayton's bluff, on P. Kelly's place, is a covered cave in the white sandstone, not far from Carver's cave, in which is a deposit of clay containing lumps, and some large pieces, of what goes by the local name of "kaolin." It is purely white, tasteless, and gritless, and seems to be the same as the white veinings found in the lacustrine clay of the Red river valley. This clay is said to completely fill the cave, which was discovered in digging to make room for a house and barn in the lower part of the bluff. The clay resembles that seen at Mankato in the nooks of the Shakopee rocks, as described in the Second Annual Report, but it has not been possible to give it, nor the cave, any satisfactory examination. It is probably of the nature of Carver's cave itself; and they should both be carefully examined for traces of ancient habitation.

In another part of the Annual Report for 1877 will be found further account of early man in Ramsey county, and illustrations of some implements found in St. Paul.

The survey of Ramsey county was facilitated by the active interest and guidance of Hon. C. S. Bryant, of St. Paul.

VI.

THE GEOLOGY OF ROCK AND PIPESTONE COUNTIES.

Situation and Area.

These counties form a rectangle running north and south, in the very southwestern corner of the State, and border on Iowa and Dakota. They have a width of a little more than three government towns, and each a length of four.

Surveying Statistics of Rock County.

BY F. E. SNOW.

Township.	Range.	TOWNSHIP LINES.		SUBDIVISIONS.	Acres.
		When Surveyed.		When Surveyed.	
101	44	S..............	August..........1852	September..1869	23,085.46
...	..	N. E. W.......	July, August....1867	....	....
102	44	N. E. S. W	July, August....1867	September..1869	22,929.55
103	44	N. E. S. W	July, August....1867	September..1869	23,078.93
104	44	N..............	September......1858	October......1869	23,081.10
...	..	S. E. W........	July, August....1867	....	....
101	45	S..............	July............1852	November...1869	22,948.32
...	..	W..............	September......1858	....	....
...	..	N. E...........	July, August. ..1867	....	....
102	45	W..............	September......1858	November...1869	22,941.68
...	..	N. E. S........	July, August....1867	....	....
103	45	W..............	September......1858	October.....1870	22,997.45
...	..	N. E. S........	July, August....1867	....	....
104	45	W. N...........	September......1858	October.... 1870	22,974.94
...	..	E. S...........	July, August....1867	....	....
101	46	S..............	July............1852	September...1870	23,048.40
...	..	E..............	September......1858	....	....
...	..	N. W...........	September......1867	....	....
102	46	E..............	September......1858	September..1870	23,072.24
...	..	N. W. S........	September......1867	....	....
103	46	E..............	September......1858	Sept., Oct...1870	23,038.05
...	..	N. W. S........	September......1867	....	....
104	46	E..............	September......1858	July.........1871	23,100.92
...	..	N..............	September......1861	....	....
...	..	S. W...........	September......1867	....	....
101	47	S..............	July............1852	September...1870	7,928.52
...	..	W..............	July............1859	....	....
...	..	N. E...........	September......1867	....	....
102	47	W..............	July............1859	September...1870	7,889.56
...	..	N. E. S........	September......1867	....	....
103	47	W..............	July............1859	September...1870	7,862.81
...	..	N. E. S........	September......1867	....	....
104	47	W..............	July............1859	July.........1871	7,788,18
...	..	N..............	September......1861	....	....
...	..	E. S...........	September......1867	....	....
			Total	number of acres	307,716.11

Surveying Statistics of Pipestone County.

BY F. E. SNOW.

Natural Drainage.

The drainage is toward the south and southwest, and finally enters the Missouri river near Sioux City, in Iowa, being the only water from the State of Minnesota that takes that route to the Gulf of Mexico. The main stream is Rock river, which flows almost due south, receiving several tributaries from the east, but none that are important from the west. Other streams rise west of Rock river, having their headwaters near that stream, but flow westward, leaving the State, and finally reaching Big Sioux river. These latter are the Flandrau, Pipestone, Splitrock and Beaver creeks.

These streams are all small, and in the summer time some are rather valleys where gathers a little water, than living streams. They furnish no water-powers that have been improved, as yet, though without doubt, some parts of Rock river would furnish sufficient fall for milling by a little artificial aid.

Surface Features.

These are emphatically prairie counties, and are nearly level over large tracts. They are undulating in their eastern portions, due to the existence of more numerous streams whose valleys lie rather deeply below the general level. Along the valley of Rock river and its tributaries is the greatest diversity seen in these counties, and this is mainly confined to Rock county, though the high peninsula between Rock river and Chanaranbie creek in the southeastern part of Pipestone is a prominent object in the horizon for many miles.

Rock river valley is about a mile or a mile and a half wide. The immediate banks are from six to ten feet above the water, and are composed of gravel, which is sometimes coarse, and is very largely made up of limestone. The outer banks are from fifty to seventy-five feet higher, and on the eastern side are more stony with foreign boulders than on the west, a circumstance, however, which may be owing to the action of the prevailing western winds, which would uncover and keep bare the coarser materials of the surface by blowing away the sand and clay during the dry and windy months of the year, while the bluffs on the west side would not only not receive such winds, but would serve to collect all particles flying toward the east from the prairie above.

The range of high rocky land running northwest from Mound, near Lu Verne, is a conspicuous object in the horizon from the north and east, and looks like the Coteau from Marshall. The highest point is where it breaks off squarely to the valley of Rock river, and

istinctively known as "The Mound." There is no rock south ast of that, except occasional boulders, which are common along drift bluffs of Kanaranza creek.

'he country northeast from Lu Verne, along the Champepedan ·k, and toward the "Lost Timber" (Sec. 2. T. 105, R. 43 W.) is ;eneral. a fine undulating prairie, the subsoil being a yellowish, relly and stony clay, with rarely a visible boulder.

he bluffs of Chanaranbie creek and Rock river, in Pipestone nty, are abrupt and from 75 to 100 feet high, composed of drift. re are here a great many short, sharp ravines, branching from se valleys, cut deeply, like the ravines in the bad lands of Mon- . The flat bottom lands support a heavy growth of grass.

eaver creek valley is broad, with changing rolling bluffs, about a mile wide, with no terraces. The low land is cultivable, but e water being in the valley. The upland is also undulating or ng, a prairie, with no shrubs nor trees, nor stones. The soil is loam, which becomes more and more like the loess loam of the souri, toward the south, while toward the north it is more grav- and stony. Along Beaver creek the stones are very scarce, but do occur along the brows of knolls, and are struck in digging s, even in this loam.

ipestone county is more uniformly a smooth prairie than Rock, is marked by long ridges or swells, corresponding to the low er-sheds running north and south. The subsoil of this county nearly everywhere a gravelly or stony clay, but becomes finer ard the surface, and in the soil it is rare to see a northern boulder. 'here are but few settlers in Pipestone county, and Rock county but lately been occupied. Pipestone city is a "paper town" has three houses, one of which is occupied and accommodates only post-office in the county; but it is on the line of the prob- extension of the Southern Minnesota railroad. Land in both nties is rapidly being taken both by settlement and purchase, new settlers being generally farmers from the eastern part of nesota or from further east.

THE GEOLOGICAL STRUCTURE.

he only known bedded rock in these counties is a red quartzyte, bably the equivalent of the New York *Potsdam Sandstone*, but ch Dr. C. A. White, of the Iowa survey, has designated the *Sioux rtzyte*, as it is seen to outcrop in the extreme northwestern cor- of Iowa. Of this the largest exposures are in Rock county, but best known is at the famous "Pipstone Quarry," near the cen- of Pipestone county.

As this locality has become somewhat famous on account of the extensive use made of the red pipestone by the Indians, and the difference of opinion expressed by scientists as to its origin and age, the following *resume* will be of interest:

The first written account of the quarry was by George Catlin, found in the 38th volume of the First Series of the American Journal of Science and Arts, p. 138, in a letter addressed to Dr. C. T. Jackson, to whom he also sent a sample of the pipestone for analysis. The journey was made on horseback from the falls of St. Anthony, in the summer of 1836, in company with "a young gentleman from England, of fine taste and education," and a single Indian guide. Mr. Catlin describes the quarry as "on the very top" of the Coteau des Prairies which rises above the country about it with graceful and almost imperceptible swells. The quartzyte he regards "a secondary or sedimentary deposit," but no further defines its supposed age.

Jean N. Nicollet visited the quarry in July 1838, as is plainly shown bv his own name and date for that year, together with the initials of his companions, boldly and artistically cut on the quartzyte, at the top of the ledge, near the "Leaping Rock," and a little north of where the creek passes over the brow of the escarpment. His "Report, intended to illustrate a Map of the Hydrographical Basin of the Upper Mississippi river," is "Document 237," of the second session of the 26th Congress, ordered printed Feb., 1841. He gives no opinion of the age of the rock, but quotes Dr. Jackson's analysis of the pipestone, or *Catlinite*, as it was named by Jackson. "As a mineralogical species it may be described as follows: compact; structure slaty; receiving a dull polish; having a red streak; color blood red, with dots of a fainter shade of the same color; fracture rough: sectile; feel somewhat greasy; hardness not yielding to the nail; not scratched by selenite, but easily by calcreous spar; specific gravity 2.90. The acids have no action upon it; before the blowpipe it is infusible *per se*, but with borax gives a green glass," While Prof. Jackson assimilates it to *agalmatolite* (*pinite* of Dana) Nicollet regarded it as differing very materially from it in general aspect, its conduct before the blowpipe, and its total insolubility in sulphuric acid.

Prof. James Hall, next in chronological order, read a paper before the *American Philosophical Society* in June, 1866, in which, among notes on the geology of some of the western portions of Minnesota, he classes the red quartzite as Huronian. He imagines the Coteau des Prairies caused by a vast synclinal in the rocks of this age. He did not see the pipestone quarry itself, having only gone to Lake

Shetek, where he describes a wall of rock which he thinks the same in age. His examinations were made in 1865. His is the first attempt to fix the age of this rock.

Dr. F. V. Hayden visited and examined the locality in October, 1866, and his account is in the *American Journal of Science and Arts* for January, 1867. After examining rock of the same kind on the James and Vermilion rivers, in Dakota, and at Sioux Falls, on the Big Sioux river, he gives an interesting detailed description of the quarry, and inclines to the opinion that the quartzyte is supracarboniferous, Triassic perhaps, or an extension downward of Cretaceous No. 1.

Dr. C. A. White has given a description of a "Trip to the Great Red Pipestone Quarry," in the *American Naturalist* for 1868–9, but he does not there state anything concerning the age of these rocks, though elsewhere, he has ranked them as pre-Silurian, and named the formation the "Sioux Quartzyte." (Geology of Iowa, 1870).

The reader is further referred to the first and second Annual Reports for reasons for believing this formation to be the equivalent of the Potsdam sandstone of New York.

The known area of this rock in Rock and Pipestone counties is approximately marked out on the accompanying map, but there is much probability of its being much greater, and perhaps to include the greater portion of both counties. The Cretaceous formation, no doubt, also occurs in the northern part of Pipestone county, and overlies unconformably the quartzyte in other places, but it has not been seen. Dr. Hayden has mentioned such facts in his account of the geology of southwestern Dakota, occurring at or near the mouth of Firesteel creek, on the James river.

At the Red Pipestone quarry there is a ledge of rock which runs north and south nearly three miles. This ledge of rock consists of layers of red quartzyte that have a dip of fifteen or twenty degrees toward the east, so that the rock soon disappears under the prairie in that direction, but presents a nearly perpendicular escarpment toward the west, formed by the broken off heavy layers of the rock; though its greatest hight, which is not more than 25 feet, is a little north of the present pipestone quarry. It also gradually disappears under the prairie both toward the north and toward the south, the lower ground on the west of the escarpment slowly rising, in those directions like the sides of a basin, and coalescing with that on the east of the ledge. A small stream, dry some parts of the year, known as Pipestone creek works northwestwardly and passes over the ledge from the upper prairie to the lower with a perpendicular fall of about 18 feet. In the vicinity of this fall, and also at one or

two places further south, are dwarfed bar-oaks and shrubs, but the country in all directions for many miles is a prairie which has a great monotony of surface. It is not on the top of the Coteau de Prairie, as supposed by Catlin, that range of hills being 25 or 30 miles further northeast. Mr. Catlin seems to have correctly described the eastern ascent of the Coteau as rising with almost imperceptible swells above the prairies further east, but failed to observe when he passed down the western slopes, that the real Coteau dies out still more insensibly into the prairies on the western side. The Coteau passes nearly through the middle of Lyon county, the northeastern quarter of Murray, the southwestern part of Cottonwood, and leaves the state along the western side of the DesMoines river, in Jackson county, gradually becoming less noticeable. It is characterized by numerous lakes and gravelly drift hills. It is a vast glacial moraine, comparable to the ridges in northwestern Ohio and the "Kettle Range" in Wisconsin, but is the most remarkable as it is the most extended glacial moraine known in the United States if not in the entire world. It runs along the east and north side of the Missouri river till it passes out of the United States into British America.

The little stream which crosses the rock at the pipestone quarry widens out into a lake just before passing the ledge, making Pipestone lake, and again after passing it, it forms Crooked, Duck and Whitehead lakes in the same way. In these lakes water stands constantly.

The rock itself in general is exceedingly hard, in heavy layers of one foot, or of two or three feet, and is separated by jointage planes into huge blocks of angular shapes that lie often somewhat displaced or even thrown over entirely by the action of the frost through many winters. Thus, there is a rough talus along the foot of the escarpment where grow a few bushes and small oaks, protected from the prairie fires by surrounding masses of fallen quartzyte. The rock is sometimes pinkish and massive; when blood-red it is more apt to be thin-bedded.

The real "pipestone quarry" is situated about a quarter of a mile west of this ledge and in the low land of the lower prairie. Earlier diggings seem to have been opened in the superficial outcropings of the pipestone layer, and to have followed a'ong its strike north and south nearly a mile, without penetrating very deeply into the rock. The layer which furnishes the pipestone is about 18 inches thick, and is embraced between heavy layers of the same rock as the ledge already described, and they all dip together toward the east, and of course run under the main escarpment. The present quarrying is

ittle east of the line of old diggings, but follows along the strike the formation the same as the other, the only difference being in ving greater depth (the pipestone layer is about 6 feet under the ound here) and in the difficulties encountered in removing about e feet of very firm, pinkish quartzyte in heavy beds.

The Catlinite itself is a fine clay varying in color from blood-red to le red, or pinkish, or even to a pale yellowish red. The lighter lors fade into the darker, but sometimes the light appears in the d as round spots, on a polished surface, but the red is not thus stributed through the lighter shades. It has, of course, suffered the metamorphic influences that the quartzyte itself has, but it s not lost its distinctly bedded structure, which may be seen when amined microscopically in polished thin sections. Indeed it seems have a laminated structure ; and the different shades of color pear sometimes to be due to openings and fissures produced in the d clay and becoming filled with sediment of a lighter color. It seems be made up of little grains of quartz having an abundant cement red ferric oxide, the alumina present (as indicated by chemical alyses) being mixed rather with the latter than combined with e former.

Prof. Peckham, who has analyzed for the survey samples of the l and of the pale red pipestone, makes the following report :

f. N. H. Winchell :

r DEAR SIR—I have the pleasure to report the following analyses of serial bers 52 and 53 :

No. 52—Pale Catlinite.

ic oxide	SiO_2	58.25	per cent.
inum oxide	Al_2O_3	35.90	"
er	H_2O	6.48	"
Total		100.63	

e aluminum oxide is a trifle too high and contained a trace of iron (Fe_2O_3.) specimen did not contain an appreciable amount of either lime or magnesia.

No. 53—Red Catlinite.

cic oxide	SiO_2	57.43	per cent.
minum oxide	Al_2O_3	25.94	"
ric oxide	Fe_2O_3	8.70	"
ater	H_2O	7.44	"
Total		99.51	

This specimen contained in addition a trace of both lime and magnesia.

A comparison of these results with those given in Dana's Mineralogy, ed. 1870, confirms the statement there made that Catlinite is a rock and not a mineral. The substance appears to be an indurated or partially metamorphosed clay containing a variable amount of ferric oxide and water.

An analysis by the late Dr. Jackson, of Boston, (Am. Jour. Sci., I. xxxv., 388) gives the following in 100 grains:

Water	8.40
Silica	48.20
Alumina	28.20
Magnesia	6.00
Per-ox. iron	5.00
Ox. Manganese	.60
Carb. lime	2.60
Loss (probably magnesia)	1.00
Total	100.00

These results indicate a considerable amount of earthy carbonates and when compared with those given above show that the rock is quite variable in composition. Neither of the specimens analyzed by myself was of the spotted or mottled variety, which *may* account for the presence of the earthy carbonates in the analysis by Dr. Jackson.

The red variety was found to be much more difficult to decompose by fusion with alkaline carbonates than the average silicates. It was found necessary not only to reduce it to an impalpable powder but to prolong the fusion to from eight to ten hours to insure complete decomposition.

Respectfully submitted,

S. F. PECKHAM,

MINNEAPOLIS, MINN., May 20, 1878. *State Chemist.*

Southward from the region of the Pipestone quarry the land continues high, and in some instances there are ridges, or long knolls, of drift, that are broad and evenly rounded over by a thin loam. The first exposure of the rock, in the vicinity of the road to Lu Verne, is on Sec. 13, T. 105, R. 46, along the south side of the valley that crosses westwardly near the centre of the section. It extends about a mile east and west. It here is seen to form an undulating floor on which the loam is thinly spread. It is hard, massive, pinkish-colored and superficially vitrified, in some places also showing two directions of glacial striæ, one being by compass nearly N. and S. and the other S. 52 deg. E.

The same line of rocky outcrop extends westwardly to the Split-rock creek, and along that creek and its eastern tributaries as far as it continues in the State. It seems to have a changeable dip, but nowhere presents perpendicular bluffs.

Two and a half miles further south on N. E. ¼ Sec. 36, is another exposure of the same rock, along a similar shallow ravine making westward—and again about half a mile further south on the high prairie.

At a point about ten miles north of Lu Verne this rock becomes frequently exposed both in the valleys and on the hills and continues so to the Mound, near Lu Verne, when it suddenly breaks off along the west side of Rock river, and is not known to the south of that place. Throughout this distance it forms a high plateau three or four miles wide and about a hundred feet higher than the prairies east or west, but the surface, though frequently rocky, is not rough. It is undulating ; and the plateau sinks gradually down tothe level of the rest of the country on either side. This plateau terminates abruptly in a rocky and precipitous bluff facing southeastward, three miles north of Lu Verne in what is known as "The Mound." There is a very large rocky outcrop in Secs. 4, 5, 6, 7 and 8, T. 103 N., R. 45 W. There are less frequent exposures in Gregory township, and the town next west. The Splitrock creek which crosses the northwest corner of Rock county has frequent exposures both in Rock and Pipestone ; but in Pipestone the rock range veers toward the east, into the centre of T. 104. R. 46 W., and disappears till reaching the region of the Pipestone quarry. In the N. W. part of Mound township the rock dips N. W. with a thrown, or twist, which, by slightly changing it, brings it soon below the surface. Indeed there seems to be a succession of ridges or swells, with changeable dip, though the most observable is to the northwest, about 10 degrees. These ridges are not covered with gravel or sand like similar ridges already mentioned east of the Coteau, under the operation of glacial forces, (ice and water) but while they occupy the grand divide of the county, they are nearly bare, on their tops and along their slopes, or are thinly covered with a gravelly loess loam, while the drift, even the stony clay that has been largely attributed to ice, occupies the valleys between to the thickness of at least 30 or 40 feet. On the top of some of these ridges, apparently near the top of this formation, the rock is conglomeritic. This occurs in large superficial areas, planed and smoothed down (rarely glaciated) and the colors of the pebbles, usually not larger than beans, give these spots a blotched and variegated mottling. The pebbles are mainly white, but some are jasper-red and some purple.

All over these ridges, which vary from a quarter of a mile to three or four miles in length, and are for the most part thinly covered with soil and turf, there are little nests of large blocks of quarzyte

piled so together that they seem to have been thrust up from below by some force. The edges of these blocks are squarely broken off, and slope toward each other, *i. e.*, toward the centre of the pile, while the blocks themselves lie so that their upper surfaces slope in all directions away from the center. Similar upheaved spots occur on the red quartzyte outcrop near New Ulm, and were described in the report for 1873. They were then attributed hypothetically to recent igneous forces. These upheaved spots vary from five to fifteen feet in diameter, or perhaps more. They may have been caused by ice, *i. e.*, alternate freezing and thawing with the change of seasons, aided by the force of vegetation and a little soil gradually getting into the openings.

At "The Mound," where this high land terminates abruptly, and faces the valley of Rock river, the elevation is about 175 feet above the river. The perpendicular bluff of rock is from 40 to 60 feet in its highest part; but owing to a dip of about 20 degrees from the horizon, nearly west, or partly northwest, and to the breaking off of the upper layers causing a gradual slope from the brow of the hill backward through several rods, the actual thickness of beds visible may be 150 feet. The rock here also appears to be almost entirely a reddish or pink, heavy-bedded, quartzyte. If wrought there might be some softer and thinner layers discovered in the angles of the talus, but the refractory nature of the great mass of it will cause it to be used but sparsely for building. The main bluff curves westwardly at both ends, and by reason of the dip and ravines that enter the valley from the west, its exposed layers gradually disappear under the soil in that direction, and the rock is lost in the prairie.

Near the base of the bluff of perpendicular rock, on a slope which descends to the river, once probably covered by the water of the river, on some of the lowest beds, the rock has the general shape of glaciation, but there are no striæ, the surface showing rather the action of water. On the top of the bluff are glacial striæ running S. 20 deg. W. by compass. Ten miles northwest of Lu Verne such marks run N. and S.

The Drift.

The most important fact in connection with the drift of these counties is a gradual transition, from north to south, from drift clay, with stones and boulders to loam clay that has all the characters of the well-known loess-loam of the Missouri valley. The northern part of Pipestone county lies not far from the Coteau du Prairie,

which is a vast glacial noraine of drift materials, and is even affected somewhat in its contour by the westward decline of the Coteau to the prairie level. It is as characteristically a hardpan clay—the main mass of the drift, in this part of Pipestone county—as in any part of Minnesota. In traveling southward there is a gradual superficial change in all its characters. This change pervades at first but a small thickness of the deposit but by degrees involves the drift to the depth of 20 feet. At first there is a diminution in the number of visible boulders; then a smoothness in the creek bluffs; then a gravelly clay on the surface, fine and close; then a closeness in the prairie soil; then, in digging wells a few limy concretions are seen mingled with small gravelstones, and at last a fine, crumbling loam clay that cannot be distinguished from the loess loam, which extends to Sioux City in Iowa, and there *is known* as the loess-loam of the Missouri valley and has a thickness of several hundred feet. Wells dug in the southwestern part of Rock county demonstrate also a similar *perpendicular transition from loam to drift clay*, the former being true loess-loam and the latter true hardpan, or boulder clay. This appears like rank heterodoxy, but it is not a matter of opinion nor theory. It is the result of actual observation. The writer was as much surprised to find it as others will be to read it, and it appears almost inexplicable. The writer had abundant and favorable opportunity for observing this change in the grades and cuts of the new railroad from Lu Verne to the State line, and verified it in wells dug, and being dug, in that part of the county. In some places the loam passes below into a quicksand.

We have here then a series of changes by which, between the Coteau and Sioux City the loess-loam is produced from the drift hardpan, by the slow withdrawal of the stones and gravel, and the gradual predominance of water-action over ice-action, the Coteau being the limit of unmodified ice-action involving the whole drift sheet. It is not impossible that ice, in a broad sheet, underlay the surface, embracing the now underlying hardpan, while superficial waters disturbed and modified the surface of the drift for some distance south of the Coteau. Thus it seems that, by the agency of water very largely, a considerable tract of country was covered by drift which differs at first but slightly from the true hardpan, but at points more removed from the field of glacial action, becomes more and more clearly a water-deposit. This change could be observed only in a broad, level tract like southwestern Minnesota. This southward conversion of the stony and gravelly clay into the loess-loam must have been the result of copious drainage and wash from the northern drift, but a wash that seems to have been so gradual,

and yet so profound in its effect, as to have embraced at once a great thickness of the drift materials, causing them to flow more like a pasty mud at first, than water, but finally becoming simply a muddy water. This process is perhaps what covered the extensive buried soils and vegetable remains in Fillmore and Mower counties, beyond the limits of the last ice-period, without wholly disrupting them, and perhaps will account for the same phenomenon in Ohio and Illinois. It seems evident that the vast moraines of the northwest, where, in similar topography, the changes witnessed in the drift must be due to changed climatic conditions, mark great epochs in the history of the ice-age. There are two such that cross Minnesota, the older being the Coteau, and the younger the Leaf Hills. Corresponding to the latter the Kettle Range in Wisconsin seems a parallel phenomenon. [See also the report on Ramsey county.]

There is evidence of glacier-action, or what has been recognized as evidence of glacier-action, in Rock county south of the Coteau. The quartzyte is polished, striated, and sculptured superficially on the tops of the ridges in the central part of the county as only glacier-ice is known to do. At the Pipestone quarry, (near "The Three Maidens") such marks run 22 deg. W. of S. by compass. On the strike of the ledge at the same place they ran S. 10 deg. E. varying to 20 deg. W. of S. On Sec. 13, T. 105, R. 46 W. they run in two directions, one direction being nearly N. and S. and the other S. 52 deg. E. within the valley of a little stream. On the rock near the top of the southern side of this valley, which is a slight, shallow depression, glacial marks runs S. 22 deg. W. This is but a few rods from the last observation above. At another point, about ten miles north of Lu Verne, glacial marks were observed running nearly N. and S. On the rock at "The Mound" they run S. 20 deg. W. by compass. It seems almost impossible that in so level and open a country, and on the same rocks, without apparent cause, the glacier which must have been hundreds of miles wide, if it existed here at all, could have taken so diverse directions in so short distances. It cannot be doubted, however, that this marking was done by a force that exerted a great pressure at the same time that the marks were made. This pressure is evinced not only in the marking itself, which is on the hardest formation found in the State, but in the innumerable checks and flaws that cover the surface where this rasping has taken place, and yet leave it in the main a smoothed and rounded or *stossed* surface. These checks run curvingly downward at varying angles with the surface, and to all depths less than an inch, but usually less than one-sixteenth of an inch, and indicate perhaps an incipient crushing to the depth of at least an

h. They show in what manner the rasping reduced the original
jecting knobs. Where the natural seams or planes of jointage
ss the rock, these little checks are larger, causing the quartzyte to
p off sooner and deeper with a curving and choncoidal fracture.
is prevailing direction is transverse to the crushing force, so that
rock, along some grooves, has a short conchoidally laminated
icture transverse to the grooves, penetrating it to the depth of a
irter to half an inch, exhibited now in a series of little curving
rows where the laminæ broke off successively, the concavities of
laminæ being toward the north.

FIG. 10.

N.

N.

Striated red quartzyte in Rock county.

'his marking is represented in Fig. 10, but the figure does not
w a great many fine checks with which the surface of the rock
early covered, but it shows correctly the prevailing direction of
curvature, and its relation to the moving force. This manner
glaciated marking is visible on Sec. 13, T. 105, R. 46, and also on
ie Mound," near Lu Verne. It can be compared to a cross-
ined planed board, where the plane has been driven against the
in, except that the cut edges are curved so as to present their
cavity toward the cutting or planing force.
t has already been mentioned that there are but few boulders in
ck county. They are generally confined to the creek bluffs and
leys. Even on the plateau caused by the red quartzyte running
n near Lu Verne northwestward they are not seen, or are so rare as
e noteworthy. This is an anomaly. In ice-covered regions, *i. e.*
regions known to have been last passed over by the ice of the
't epoch, there would be no place where foreign boulders would
found more thickly than on such rocky elevations.
n traveling over the plateau of quartzyte, about on Sec. 16,
und, one large solitary granite boulder may be met with. It
directly on the quartzyte. It is rough and granulated, and there
circular excavation or concavity in the soil in which it lies. It
bout ten feet long and five feet high, and has a groove horizon-

tally circumscribing it about a foot in width and three or four inches deep. Taken altogether it immediately reminds the beholder, not less by its general shape than by this groove, of the *stone hammers* sometimes found. Its size precludes its being one, but its shape is very like them. The groove may have been formed by the action of ice and water on its sides, as it has the appearance of lying in ordinary seasons in a little lake of water, which at the time of this examination was entirely dried up. This boulder, like the "Three Maidens," at the Pipestone quarry, must be referred to the date of the boulder clay, and in that case it was not disturbed by, but probably witnessed, the spreading the loam which came later.

The "Three Maidens," and the three others, (smaller) that make up the cluster of six granite boulders lying just outside the Indian Reservation at the Pipestone quarry, also rest on the surface of the red quartzyte about 60 rods southeast of the quarry and at the foot of the long ledge or escarpment that passes north and south. They evidently once constituted one immense boulder and have become six from the falling apart, under the influence of frost, of the granite along its natural seams or joints. Such a separation of large boulders is sometimes seen on the prairies in Minnesota under circumstances which demonstrate their former entirety.

On the surface of the glaciated quartzyte about these boulders, which is kept clean by the rebound of the winds, are a great many hieroglyphic inscriptions, which were made by pecking out the rock with some sharp-pointed instrument. They are of different sizes and dates, the latter being evinced by their manner of crossing and interfering, also by a difference in the weight of the instrument used. They generally represent some animal, such as the turtle, wolf, bear, badger, buffalo, elk, and the human form. The "crane's-foot" is the most common. They are very similar to those represented on Plates XI and XII of Vol. II, of the "Bulletins of the U. S. Geol. and Geog. Sur. of the Territories," accompanying the article of W. H. Holmes on Ancient Ruins in Southwest Colorado. The Indians regard the "Three Maidens," represented by the three larger boulders, as the maids from whom the tribes sprung after the destructive anger of the Manitou had slain the people. It would seem as if any warrior or hunter who had been fortunate in the chase and happened to pass here, left his tribute of thanks to the Great Spirit in a rude representation of his game, and perhaps a figure of himself, on the rocks about these boulders. In some cases there is a connection of several figures by a continuous line, chipped in the surface of the rock in the same manner, as if some

end or adventure were narrated, but for the most part the fig-
s are isolated. This is the "sacred ground" of the locality.
ere are hieroglyphics at no other place around here, though
re is abundance of bare rock.

Common Wells in Rock County.

he water of wells in the loam, or in the drift-clay, is very hard.
s is caused by a large amount of limestone gravel disseminated
ough all the materials of the drift, derived from the limestones
Vinnipeg. There is occasionally a water which has a distinctly
line character, but this is not common. Nearly all the wells of
county are curbed with pine boards, and from that fact great
bers of them are contaminated with the organic decay known
esult from that practice, and a number were examined that
very foul from that cause. Several recent cases of typhoid
r at Lu Verne are directly referable to that cause, and no doubt,
e facts could be known, many others in the country could be
unted for in the same way. The curbing of wells in the prairie
ons with pine boards or planks is very common, owing to the
of convenient stone, and the ease of constructing such curbs of
d; but it is a practice which all well-diggers should loudly and
istently protest against, and which all the owners of wells should
ontinue, as it is a fruitful source of foul water, causing intestinal
ses and typhoid fevers. The adjoined table shows the depth
character of some of the wells of the county.

Wells in Rock County.

Owner's Name.	Location.		
A. L. Marsh	S. W. ¼ Sec. 4, La Verne	3	
—— Stone	La Verne	1	
—— Taylor	N.E. ¼ Sec. 10, La Verne	8	
W. O. Crawford.	S. E. ¼ Sec. 20, Beaver Creek.	2	ow
—— Kennedy	N.W. ¼ Sec. 35, La Verne	4	
—— Taylor.	N E. ¼ Sec. 10, La Verne	1	ght,
	S.W. ¼ Sec 8, La Verne	4	er ;
rthington & Sioux Falls R R	Sec. 17, La Verne	1	
Samuel Spalding.	Sec. 20, La Verne	2	
—— Shively	Kanaranza	2	
Henry Halbut	Magnolia	3	
E. Sheldon	Beaver Creek	1	idy soft
Lary McDermott.	Mound.	2	
Samuel Spalding.	Sec. 20, La Verne	1	
C. B. Henton	Sec. 22, Beaver Creek	4	
W. T. Henton	Sec. 30, Beaver Creek	6	
C. Williams	Sec. 28, Beaver Creek	9	
Wm. Grout	Sec. 24, Beaver Creek	2	
La Verne House.	La Verne	1	

Material Resources.

These counties contain some of the best farming lands in the state. They are not broken by rock exposure (except through the central part of Rock county), so that nearly all their area is tillable. The rocks that underlie them are not known to hold anything of great economical value. They will serve as a building material, but are rather hard even for that, and it may be found more economical to bring in by railroad the building stones of the eastern counties. The main material product of these counties is now, and will always remain, *wheat*, of which they will produce as much to the acre as any county in the State.

VII.

PALÆONTOLOGY.

Notes on the Fossils of the Trenton in Minnesota.

During the month of July, 1877, some time was given to the examination and arrangement of some of the fossils of the Trenton in the collections of the survey, continuing thus the work begun the season before. As but little time could be had for this part of the work of the survey, the results are meager. The fossils represented by the following list are additions to those named in the report of last year. It was found that a greater range of authorities for reference was necessary for the reliable identification of our specimens, and measures have been taken for procuring many foreign and American works, containing descriptions of the fossils of this horizon.

By reference to the Museum Report accompanying this, the corresponding numbers of the Register will be seen, and other particulars of each species ascertained.

No. 90. *Asaphus extans, H.?* (Compare No. 399). This specimen has been in the museum a number of years, and its origin is unknown; but its similarity to specimens obtained of Mr. W. D. Hurlbut, from Trenton Falls, N. Y., renders its source less doubtful. It is probably from the Trenton formation in Minnesota. It has a tuberculated surface instead of a lamellose one, as *A. extans* is described by Hall.

No. 172. This block contains fragments of the crinoid of Hall, *Schizocrinus nodosus*, with an unidentifiable species of *Murchisonia*, and fragments of a trilobite. *Locality*, Pleasant Grove, Olmsted county.

No. 185. Slabs containing *Strophomena, Orthis, Chætetes, et al.* Fillmore county.

No. 186. *Orthis perveta Con.* These are considerably larger than the type specimens. They are from Taylor's quarry near Fountain. Fillmore county.

No 189. Fragments of *Asaphus gigas, H.* From Fillmore county.

No. 191. Slab with *Leptæna sericea, Sow. Orthis emacerata, H. Strophomena filitexta, H. and Strophomena, nitens, Bill.;* from Fillmore county.

No. 192. *Poteriocrinites caduceus, H. Orthis testudinaria, Dal. Rhynchonella capax, Con.* are also from Fillmore county.

No. 197. This is provisionally named *Othoceras laqueatum, H.* but the agreement is not satisfactory. *Locality*, Spring Valley, Fillmore county. (Compare No. 214.)

No. 208. *Strophomena tenuistriata.(?)* Compare Nos. 204 and 371. *Locality*, Sec. 17, Rochester, Olmsted county.

No. 214. This slab shows *Leptæna sericea, Sow. Murchisonia bicincta, H. Orthoceras laqueatum, H. Bellerophon bilobatus, Sow. Strophomena, nitens, Bill. and Rhynchonella capax, Con. Locality*, Spring Valley, Fillmore county.

No. 242. *Cyrtoceras arcuatum, H.* has been obtained from Holden, Goodhue county.

No. 243. *Oncoceras constrictum, H.* is from the same locality.

No. 252. *Orthoceras vertebrale, H.* is from the same locality.

No. 269. *Orthis subquadrata, H.* has been identified from Sec. 30, Forestville, Fillmore county.

No. 293. *Strophomena fluctuosa, Bill.* is found in the upper layers of Willson's quarry at Mantorville, Dodge county, which is in the Galena.

No. 294. *Graptolithus scalaris, Linne* is found in the same layers.

No. 297. *Discina Pelopea, Bill.* is found in the same layers. Compare No. 263.

No. 307. *Chætetes petropolitanus, Pan. ?* is found on Sec. 21, Forestville.

At Minneapolis have been identified different forms of *Rhynchonella capax, Con.* and of *Orthis perveta, Con.* The following have also been found at Minneapolis: *Orthis emacerata, H. Var. multisecta, James. Chætetes Lycoperdon, H. Murchisonia bicincta, H. Pleurotomaria subconica, H. Schizocrinus nodosus, H. Cyrtolites compressus, Con.* and *Bellerophon bilobatus, Sow.*

No. 348. *Cyrtolites compressus, Con.* occurs on Sec. 16, Pleasant Grove, also *Orthoceras strigatum, H.* (Nos. 350 and 381.)

From Pleasant Grove, Olmsted county, also comes *Oncoceras constrictum, H.* (No. 352).

No. 376. *Asaphus gigas, H.*—from St. Charles, Winona county.

No. 397. *Orthoceras vertebrale. H.*—from St. Charles, Winona county.

No. 392. *Orthis bella-rugosa, Con.*—from St. Charles, Winona county.

No. 399. *Asaphus extans, H. (?)* (Compare No. 90). This specimen was obtained of W. D. Hurlbut, and is from Trenton Falls, N. Y. It differs from Prof. Hall's description of *A. extans* in having a surface rather pustulated than lamellose.

No. 410. *Asaphus gigas, H.* and *Strophomena filitexta, H.*—from St. Charles, Winona county.

VIII.

REPORT ON THE GEOLOGY OF RIÇE COUNT

BY L. B. SPERRY.

Situation and Area.

The northern border of Rice county is about 35 miles south St. Paul, and its eastern border is about the same distance west Lake Pepin. It is bounded on the north by portions of Dakota Scott counties; on the east by Goodhue county; on the south portions of Steele and Waseca counties, and on the west by Le Su county. It is four Government townships, or 24 miles, in wid east and west. The western portion of the county is of the sa length—24 miles north and south—but the eastern two tiers townships are shorter by 5 miles.

The county contains 14 townships, each of them, except tw containing 36 square miles. Of these two exceptions, one, Bridg water, contains 40 square miles, and the other, Northfield, 44 squa miles.

Its area then is 330,240 acres, of which nearly one-half is timb land interspersed with many lakes.

There is but very little land in the county unfit for tillage.

That portion east of the Straight and Cannon rivers is the fine of prairie land, while most of that west of these rivers is, or w originally, covered with valuable timber, which, on being remove leaves a strong and fertile soil.

Fairbault is the county seat. Northfield, Morristown, Dund and Shieldsville are the principal towns.

Natural Drainage.

The drainage of the county is to the north and east. Straight river enters the county 2½ miles east of the middle of the southern border, and, flowing northward about 8 miles, forms a junction, (where the city of Fairbault now stands) with the Cannon river, which enters the county about 2 miles north of its southeast corner. From the junction of the Straight and Cannon rivers—taking the latter name—the waters flow northward and leave the county 4 miles east of the meridian line upon which the Straight river enters its borders. The western half of the county contains about a score of shallow but pretty lakes, which receive the surface waters of their localities, and empty for the most part by very circuitous routes into the Cannon. The Straight and Cannon also receive the drainage from the eastern portions of the townships through which they flow; while the eastern tier of townships, for the most part, shed their waters through small streams into the Little Cannon and Zumbro rivers in Goodhue county. The Straight river enters the county in the Lower Trenton formation, and cuts through into the St. Peter sandstone 3 miles north of the county line, near Walcott's mill.

A short distance from Walcott's the river makes an extensive bend toward the south, and on reaching Faribault has cut 80 feet into the sandstone.

At a point near the line separating Bridgewater and Cannon City townships the river has cut through the St. Peter sandstone and begins its flow over the Shakopee limestone, into which it has cut about 30 feet when it leaves the northern boundary of the county.

This descent of about 150 feet in crossing the county furnishes at least eleven available mill privileges which have been improved and are in operation.

The following tabular exhibit shows the most important and interesting facts relative to these:

Water Power Mills in Rice County.

Name of Mill.	Owner.	Location.	Stream.	No. of feet fall.	Run of Stone.	Barrels daily.
Walcott	Chaffee & Sheffield	5 miles South of Faribault	Straight R.	....	4	100
Straight River Mills	J. D. Greene & Co.	Faribault	Straight	13	3	60
Kendall	Greene & Gold	Faribault	Straight	7½	4	80
Matteson's	H. M. Matteson	Faribault	Cannon	6	4	80
Polar Star	Stock Co	Faribault	Cannon	8	7	150
Warsaw	....	Warsaw	Cannon	5	3	50
Hershey's	C. Hershey	Morristown	Cannon	7	2	Custom.
Roberds Lake	J. G. Scott	Outlet Roberds Lake	....	15	2	50
Cannon City	R. H. Scott	Ne'r Cannon City	Cannon	7	4	100
Dundas Mills	E. T. Archibald & Co.	Dundas	Cannon	9	8	200
Northfield Mills	Jesse Ames & Son	Northfield	Cannon	10	10	300

Surface Features and Soil.

The eastern portion of the county is, for the most part, a high and gently rolling prairie of great beauty and fertility.

Skirting the small streams there is a little timber, and along the east bank of the Straight river—and also of the Cannon, from its junction with the Straight northerly to Dundas—there is a belt of timber averaging about 3 miles wide. The soil bearing this belt of timber is sandy with gravel subsoil, and is of comparatively little value for agricultural purposes.

The surface of the southwest part of the county lies above the Trenton formation and is gently undulating.

The surface of the northeast part is more broken because the Trenton is largely carried away and the St. Peter sandstone is eroded to quite variable depths.

The western portion of the county also is quite undulating—sometimes rough and hilly—and over the greater part is covered with heavy timber, interspersed with many beautiful but shallow lakes.

The surface soil is usually a dark loam, but is generally very thin. A strong and productive yellow clay overlying thick deposits of blue clay—which is frequently exposed—characterize the soil of this region. Maple, Elm and Basswood characterize the timber.

There are about twenty beautiful lakes in the western half of the county, ranging from one to ten square miles in area, and varying from ten to fifty feet in depth. These lakes abound in fish and are much frequented by sportsmen.

The southwestern part of the county, being lower and more sandy, furnishes better beaches for its lakes than are found further north where clay deposits overlie and conceal the sand.

I am under obligation to Surveyor Jewett, of Fairbault, through whose kindness I secured the following:

SURVEYOR'S NOTES OF RICE COUNTY.

Township 109, Range 19.—Richland.

Rolling prairie. Soil a black loam with clay subsoil. The north branch of the Zumbro river flows easterly through the northern part, taking the surface water of nearly the whole town.

Township 110, Range 19.—Wheeling.

Surface rolling, becoming bluffy along the creek. The east branch of Prairie creek heads near the center of the town, where there is a body of about one section of timber. This creek flows northeasterly, and forms a valley from one-eighth to one-fourth of a mile wide, about fifty feet below the general level of the prairie. From the bluffs along this valley in the north part of the town limestone crops out with sandstone below.

Town 111, Range 19.—Northfield.

Surface mostly a high rolling prairie sloping toward Prairie creek, which runs northeasterly through the township; a part of the town is drained northwesterly toward Cannon river. Soil a rich black loam; clay subsoil; limestone in bluffs along the creek; sandstone below.

Town 109, Range 20.—Walcott.

Surface rolling to hilly; slopes toward Straight river, which runs northerly through nearly the center of the town; a body of timber three to four miles wide lies on the east side of the river. Limestone appears in the bed of the river as far north as Sec. 4. North of this point it appears in the bluffs from 20 to 50 feet above the river. Soil in the river valley light and sandy with gravel subsoil; rest of town black loam over clay.

Town 110, Range 20.—Cannon City and Faribault.

Surface quite rolling; bluffy along the east side of river. The Straight river forms junction with the Cannon river in Section 30, from which point the Cannon river runs northeasterly to the centre of the north boundary. The two eastern sections are prairie; the remainder of the town is timber land: soil a rich loam with clay subsoil. Limestone crops out of river bluffs with sandstone below; a small lake in Sec. 15, containing 45 acres.

Town 111, Range 20.—BRIDGEWATER.

Land rolling; becomes bluffy along the river as far north as Section 10. Cannon river flows northeasterly through the eastern part of the town. About six sections on east side of town are prairie; rest of town timber land; soil black loam with clay subsoil, excepting on river bottoms, where the soil is light and sandy over a gravelly subsoil; limestone in the bluffs along the river south of Section 10. In Section 1 it appears in the bed of river.

Town 109, Range 21.—WARSAW.

Surface rolling; drains toward the north; Cannon lake, with an area of 1475.28 acres, lies in the northwestern part of the township; four sections of land northwest of lake are timber land; rest of town is prairie and brush land; soil black loam over clay subsoil.

Town 110, Range 21.—WELLS.

All timber land excepting Sections 35 and 36; surface rolling; soil black loam with clay below; area of meandered lakes 2114.44 acres; drains toward the south.

Rown 111, Range 21.—FOREST.

All timber land; surface rolling; draining eastward; soil black loam, clay subsoil; area of lakes, 1694.41 acres.

Town 112, Range 21.—WEBSTER.

Timber and brush land; surface rolling: drains to the south and east; soil light-colored loam over clay. Area of meandered lakes, 208.81 acres.

Town 109, Range 22.—MORRISTOWN.

Nine sections in southeast part prairie land; remainder of town timber. Cannon river flows easterly through the center of township; surface rolling, slopes towards the river; soil a rich black loam with clay subsoil. Area of meandered waters, 935.70 acres.

Town 110, Range 22.—SHIELDSVILLE.

Surface rolling, becoming hilly in some parts of the town; soil black loam over clay. Area of lakes, 2574.23 acres. The Cannon river heads in Tuft's lake, in Section 3.

Town 111, Range 22.—ERIN.

Surface rolling to hilly, timber and brush lands; soil rich loam over clay. Area of lakes, 856.32 acres.

Town 112, Range 22.—WHEATLAND.

Surface rolling and hilly; soil black loam on clay subsoil; timber and brush land. Area of lakes, 307.27 acres.

Timber.

As before stated the eastern portion of the county originally produced timber only along the streams. Through cultivation for shade, hedges, protection from winds, &c., timber is increasing over this area.

The western half of the county was originally covered with heavy timber—excepting a few limited, enclosed spaces, which were open prairie, or sparsely covered with oak and under-brush—and forms a part of what is denominated the "Big Woods."

This region is being cleared up rapidly and there are now many fine farms in every township of the timber regions of this county.

The following list embraces all the native trees and shrubs that were noticed during the survey. It is not believed, however, that it includes all that grow naturally in the limits of the county :

Basswood. Tilia Americana. *L.*
Smooth Sumach. Rhus glabra. *L.*
Jersey Tea. Ceanothus Americanus. *L.*
Sugar Maple. Acer saccharinum. *Wang.*
Silvery Maple. A. dasycarpum. *Ehr.*
Red or Swamp Maple. Acer rubrum. *L.*
Box-Elder. Negundo aceroides. *Mœnch.*
False Indigo. Amorpha fruticosa. *L.*
Locust. Robinia Pseudacacia. *L.* Cultivated.
Cherry. Prunus.
Red Raspberry. Rubus strigosus. *Michx.*
Blackberry. R. villosus. *Ait.*
Crab. Pyrus arbutifolia. *L.*
Dogwood. Cornus paniculata. *L'Her.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Ash. Fraxinus.
Slippery Elm. Ulmus fulva. *Michx.*
Butternut. Juglans cinerea. *L.*
Walnut. Juglans nigra. *L.*
Hickory. Carya.
Burr Oak. Quercus macrocarpa. *Michx.*
Black Oak. Quercus coccinea. *Wang.* Var tinctoria. *Bartram.*
Wild Hazle-nut. Corylus Americana. *Walt.*
Iron-wood. Ostrya Virginica. *Willd.*
American Aspen. Populus tremuloides. *Michx.*
Cottonwood. P. monilifera. *Ait.*
Large-toothed Aspen. P. grandidentata. *Michx.*
Balm of Gilead. P. balsamifera. *L.* Var. candicaus. *Ait.*
Red Oak. Quercus rubra. *L.*
White Oak. Quercus alba. *L.*
Wild Plum. Prunus Americana.
American Elm. Ulmus Americana. (*Pl Clayt.*) *Willd.*

American Crab. Pyrus Coronaria. *L.*
Black Cherry. Prunus serotina. *Ehr.*
Bitternut. Carya amara. *Nutt.*
Wild Red Cherry. Prunus Pennsylvanica. *L.*
Thorn Apple. Cratægus Crus-galli. *L.*
White Birch. Betula alba. *Var.* populifolia. *Spach.*
Small Cedar. Juniperus Sabina. *L.* *Var.* procumbens.
White Pine. Pinus Strobus. *L.*
Water Beech. Carpinus Americana. *Michx.*
Cornel. Cornus paniculata. *L'Her.*
Cornel. Cornus circinata. *L'Her.*
American Woodbine. Lonicera grata. *Ait.*
Juneberry. Amelanchier Canadensis. *Torr & Gray.*
Dwarf Wild Rose. Rosa lucida.
Pipe Vine. Aristolochia Sipho.
Grape. Vitis cordifolia. *Michx.*
Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Nine Bark. Spiræa opulifolia. *L.*
Bittersweet. Celastrus scandens. *L.*
Rose. Rosa blanda. *Ait.*
Lombardy Poplar. P. dilitata. *Ait.*
Speckled Alder. Alnus incana. *Willd.*

GEOLOGICAL STRUCTURE.

In general the drainage of Rice county is toward the north and east, which fact indicates the relative elevations.

The Chicago and Milwaukee R. R. survey (Minnesota Div.) found the elevations of the natural surface, where the railroad crosses the northern line of the county, to be over 1050 feet above the sea level. At Faribault depot it is 993 feet; at Dundas depot, 945 feet; at Northfield depot, 905 feet. The entire western half, and the southeastern portions of the county have a higher elevation. I have no means of knowing positively the relative elevations or the highest point in the county; but judging from appearances I conclude that the rolling prairie, on which Cannon City is located, is the highest by least 100 feet.

The only geological formations that appear in this county are the

Loam,
Drift,
Trenton Limestone.
St. Peter's Sandstone,
Shakopee Limestone.

In *general appearance* these formations are not unlike the same formations as they are seen in other portions of the State, and carefully described by Professor Winchell in his reports made during the past few years. Nor did I find in the county any remarkable *special peculiarities* in any of the formations.

The *Loam* is deep, dark-colored and fertile, over nearly all the eastern portion of the county; but over the western portion as a rule it is thin.

Drift, consisting largely of blue clay over-lain by a grayish yellow clay, characterizes the soil of the western half of the county. Boulders of granite, gneiss, trap and porplyry are quite abundant in some places; but fine clay, with small quantities of gravel, are the rule throughout this region. No well yet dug in the western part of the county has passed through the blue clay—though some of the wells are over 100 feet deep. A hint as to the depth of the clay is found in the fact that a well dug last season south of Rice county, about 30 miles west of Owatonna—near Janesville—after passing through 200 feet of blue clay reached a sandstone said to be identical with the St. Peter's in appearance. An abundance of good water, which rose to within 30 feet of the surface, was found between the clay and the sandstone. This fact should be considered by the residents of this drift and timber region, as many of them have failed to secure good and abundant water in the clay. Indeed there is much uncertainty about getting *good* well water in this region. Some holes at 100 feet or over fail to bring enough water for drinking and cooking purposes. Some wells that furnish an abundance of water are so strongly impregnated with mineral impurities as to be nearly useless, while others are quite pure. It is possible that good water which would rise nearly to the surface might invariably be procured by boring through the clay to the under-lying rock.

Illustrations of the peculiarities of the deposits in this region are seen in the following facts: On the S. E. side of Union Lake (7 miles west of Northfield) Mr. B. Benton dug 40 feet and secured an abundance of water, but is strongly impregnated with some mineral impurities. About 40 rods from there Mr. M. J. Punk secured better water at 16 feet; and about 40 rods further Mr. S. A. Amsden secured nearly pure water at a depth of 36 feet.

It has been supposed by some that the formation underlying the drift throughout the timber region is the Cretaceous, and I see that Prof. Harrington in his report on Steele county expresses his belief in the existence of the Cretaceous along that belt. I am not satisfied that such is the fact. To my mind there is but very little

evidence of it; but I do not desire to discuss ths matter till I have procured more light on the subject. At present my belief is that the drift rests immediately upon a thin remnant of the St. Peter sandstone. Perhaps in some places the St. Peter is all eroded so that the drift rests immediately upon the Shakopee.

Reference to the accompanying colored map of the county will show the areas of the different formations as they give evidence, by exposure and by topography, of underlying the deposits of drift and loam.

It will be seen that the Trenton limestone is nearly removed from the western part of the county. the bluffs along the Straight river to a point a little south of Faribault, and a hill near Northfield, being the only places where it occurs. East of the river, however, it is extensive, and furnishes abundance of material for building purposes of which mention will be made under the head "Material Resources."

In general character the Trenton resembles so closely that found in other parts of the State, and so carefully described in previous reports on the survey of the State, that little need be said here.

For building purposes the most of that found in this county is superior to that quarried near St. Paul, in that it contains less clay and does not weather so easily. On the other hand the Rice county limestone contains more concretionary iron pyrites, and, hence, necessitates more care in its selection for architectural purposes.

The Straight river cuts through the Trenton and enters upon the St. Peter at Walcott's mill, 3 miles south of Faribault. At a point eight miles further north the river (having now become the Cannon) has worked its way through the St. Peter and enters upon the Shakopee. The thickness of the St. Peter, in Rice county, is from 100 to 125 feet. It appears in the form of cliffs at frequent points along both sides of the river from the place where it is first reached by the Straight to the northern limits of the county, and in the northeastern part of the county it frequently appears in the hills—indeed it largely gives character to the topography of this section.

Judging from the topography also I am satisfied that many of the hills in the northwestern part of the county—in Wheatland and Webster townships—consist largely of the St. Peter; but they are so heavily covered by drift and timber that I could neither find nor learn of any exposures. In Cedar Lake there is an island the topography and flora of which indicate the St. Peter, capped with Trenton. I was unable to verify this by excavations.

There is no place in the county where the St. Peter sandstone is sufficiently compact and firm for building stone. As along the

Mississippi, it may be removed by pick and shovel. In color it is—as along the Miss. river—white to red, according to the percentage of iron, and its oxidation resulting from exposuse. No fossils are found in it here.

The Shakopee limestone is reached by the Cannon river at a point about 4 miles south of Dundas—6 milns south of Northfield.

On leaving the county one-half mile north of Northfield, the river has cut into the Shakopee about thirty feet. The map shows approximately the extent of this formation as exposed. The descriptions of it in preceding reports will apply to the formation as seen here.

Material Resources.

Limestone—both for building-stone and for quick-lime—and sand for mortar, are abundant along the valleys of the Cannon and Straight rivers, and throughout the western half of the county; while in the western portion no limestone is found.

Good clay for the manufacture of brick is sufficiently abundant all over the county.

Stone Quarries

are abundant throughout the eastern half of the county. The bluffs throughout this region are capped by a layer of the Trenton varying from a few inches to several feet in thickness.

The various neighborhoods of this section have their quarry, or quarries, from which all the building stone for general purposes is easily obtained.

Prairie Creek Valley has scores of quarries opened along its bluffs; and the valley of the Cannon looks up to as many more. Good coursing-stone is furnished at Northfield for about $6 00 per cord.

At "Fall Creek," 3 miles east of Faribault, there is a fine deposit which is being extensively quarried by its owner, Mr. Phillip Cromer. The deposit of limestone here is about 12 feet thick and is covered by about 4 feet of drift and loam. The strata in this quarry range from 3 to 12 inches in thickness and are easily quarried. The upper stratum, 8 inches in thickness, is quite light-colored and filled with fossils which are so thoroughly cemented and transformed as to render the stone compact, while its fossiliferous nature is still clearly apparent. But few specimens of fossils can be enucleated. The rock is infiltrated by gypsum and Iron Pyrites which often cement its seams quite firmly.

Mr. Cromer sells undressed stone for prices ranging from $5.00 to $15.00 per cord. The greater part of his business however is in the best varieties, which he sells by the cubic foot, at prices ranging from 25 cents to 75 cents.

Mr. N. Lord, 2 miles south of Faribault on the west side of the river, has two quarries opened, from which he has sold as high as 300 cords in one year.

In Richland township, bordering on Goodhue county, Messrs. Halver Johnson and Peter Halverson have each a fine quarry at which I saw about 100 cords ready for market.

Messrs. I. Lenhart, A. Revere, C. Stetson, D. Furguson and P. Oleson are the principal quarrymen in the vicinity of Northfield; and on Prairie Creek, in Wheeling township, Messrs. J. Thompson, A. Knapf and S. Aslagson do quite an extensive business in quarrying for their neighbors.

Lime Kilns.

The upper four strata of the Lower Trenton formation as exposed in this county furnish tolerably good material for quick-lime, though in some places the deposit is too silicious, and in no place is the lime obtained sufficiently white for fine work. When first burned the lime is yellowish in color, but when slacked is nearly white. It is excellent lime for stone work.

Though lime has been burned in every township of the county east of the Cannon river, it is not now made a regular and paying business except at Phillip Cromer's kiln, on Fall Creek, near Faribault. Mr. Cromer uses a patent kiln and burns from 3,000 to 3,500 barrels a year, which he sells at 65 cents per barrel. Three other kilns near Fairbault, owned respectively by Messrs. Pond, Lee and Lord, burn in the aggregate about 1,000 barrels per year. There is a kiln one mile from Northfield, in Dakota county, which supplies Northfield and vicinity. This kiln burns its lime from the best strata of the Shakopee formation. In general character the lime is like that of the Trenton.

Brick.

Rice county contains an abundance of clay for the manufacture of brick but none has been found sufficiently free from iron to make the white or cream-colored brick. At Faribault Mr. J. G. McCarthy makes about 700,000 per year, which he sells at $6.00 per thousand. One season he made one million. All the clay of this section is so clear that to make good brick it is necessary to add sand.

Henry Durham, of Faribault, burns about 300,000 per year and finds lying immediately under the clay a stratum of sand for mixture with it.

Another brickyard has been started at Faribault this season. Its character and success are not determined. At Prairieville, Messrs. Meisner and Leonard are making about 300,000 per year. Their brick are said to contain considerable lime and to be very good. At Morristown, Mr. Pettiel makes abont 50,000 per year. Three miles northeast ot Faribault, Mr. Dungay is making the best brick yet produced in the county. His product so far has been but about 100,000 per year, but these have been sold at from $7.50 to $8.00 per thousand. At Shieldsville one kiln is burned each year for home supply, and at Northfield one or two small kilns are burned every season.

During the past season a bank of clay has been opened about three miles from Northfield and brick for the new college building (St. Olaf's) have been burned. They are pronounced of fine quality.

In making the survey of this county I am especially indebted to Surveyor Jewett, of Faribault, for surveyor's notes of the county, to Professor J. J. Dow of the State Blind Asylum, at Faribault, for his valuable company and assistance during several of the days occupied in field work, and to Professor B. F. Thomas of Carleton College, who also rendered valuable assistance.

At some convenient time in the future I shall hope to make a *supplementary report* concerning some further facts and features pertaining to the Geology of this county.

IX.

CHEMISTRY.

REPORT OF PROF. PECKHAM.

Prof. N. H. Winchell,

MY DEAR SIR:—The chemical work for the Geological Survey during the last year has been as follows:

The analysis of the ashes of 17 specimens of peat.
The analysis of four specimens of peat as fuel.
The analysis of the water of the Belle Plaine salt spring, so-called.
The examination of 13 specimens of water from the Red River Valley.
The examination of 3 specimens of water from Brainerd.
The examination of three specimens of limestone, and of concretions from the brick clay at Minneapolis.

The results of the examination of the peat and peat ashes are herewith submitted. The water from Belle Plain was procured by myself about the first of last May. On reaching Belle Plaine I enquired for the spring from which the salt water had formerly been obtained and was informed that the bank had caved in upon it and it was filled up with earth. I was further informed that the water oozing from the base of the bluff was as salt as any water about there. I then enquired about the well and the possibility of getting some water from the boring. I was informed that no water could be procured from that source as the pump had been taken out and the level of the water was many feet from the surface. The station agent confirmed this information and I saw no other resource but to collect such water as I could from that flowing from the bluff. I brought this to the Labratory and soon found that this specimen was nothing more than hard well water, confirming the results of the examination that I made in 1873-4. I afterwards met a gentle-

man who resided in Belle Plaine, who confirmed the statement previously made to me that I had probably got a specimen of as salt water as any that was to be had there now.

Having ascertained that there was a comparatively small amount of solid matter in the water, of which only a very small proportion was chlorides of any kind, that the water contained principally bicarbonates of lime and magnesia with some sulphates and chlorides; in fact, as stated above, that the water was nothing but a hard well or spring water, I concluded that it would be useless to make an estimate of the gasses dissolved in the water, or of the substances contained in small quantity, and therefore after completing the estimates then begun I did not continue the examination further.

But one of two conclusions can be entertained in reference to these results; either the wrong water has been examined or the Belle Plaine salt springs do not yield salt water. I purposely avoided seeking any parties at Belle Plaine who had been hitherto interested in the salt operations there, as I did not wish to prejudice my results for or against any persons or interests.

The examination of the specimens of Red River water made during the summer vacation have been previously reported upon.

The examination of the water from Brainerd has been already reported upon.

The Belle Plaine Water.

Mineral matter in solution		25.10	grains	to gall.
Organic and volatile matter in sulution		5.37	"	"
Total solid matter in solution		30.47	"	"
Chlorine, Cl		3.152	"	"
Silica, SiO_2		1.465	"	"
Ferric, aluminic and phosphoric oxide	Fe_2O_3, Al_2O_3, P_2O_5	.068	"	"
Barium sulphate	Ba SO_4	A trace	"	"
Sulphuric oxide	SO_3	1.033	"	"
Lime	CaO	5.896	"	"
Magnesia	MgO	.544	"	"

Alkalies and carbonic oxide (CO_2) were not determined.

Peat Ashes.

Number.	Silica, SiO_2.	Carbon.	Iron and Iron Phosphate, Fe_2O_3 and $Fe_2P_2O_8$.	Lime, CaO.	Magnesia, MgO.	Sulphuric Acid, SO_3.	Undetermined.	Remarks.
16	51.30	1.81	9.30	10.89	6.12	5.19	15.39	CO_2 and H_2S in large amount.
17	83.13	.86	7.99	5.44	1.75	.78	.05	Alkalies a trace.
18	83.35	.03	5.29	7.39	.97	2.57	.40	Alkalies a trace.
19	72.79	.95	9.46	5.92	6.13	trace	6.25	CO_2, small; $Fe_2P_2O_8$ 5.92.
20	80.55	.75	10.23	5.61	76	1.34	......	CO_2, trace P_2O_5 trace.
21	82.71	1.19	7.41	3.18	trace	3.70	1.81	CO_2, a trace.
22	64.37	.16	21.41	6.26	1.54	7.58	......	P_2O_5 a trace.
23	72.64	.75	15.46	5.87	trace	5.73	......	P_2O_5 a trace.
24	68.06	1.34	8.82	5.03	4.81	6.53	......	CO_2 strong; P_2O_5 trace.
25	88.28	1.32	6.34	.84	.51	trace	2.71	CO_2 very small; P_2O_5 & Alkalies a trace.
26	64.27	2.80	9.75	15.75	1.77	3.69	2.57	CO_2 very strong, P_2O_5.
27	81.99	1.14	9.39	4.84	.60	1.12	......	P_2O_5, Alkalies a trace.
28	79 24	.15	5.65	7.60	.98	2.76	3.62	CO_2 strong, Alkalies a trace.
33	57.23	1.45	16.50	11.47	2.09	8.71	2.55	CO_2 strong.
34	57.35	1.48	17.09	17.84	trace	4.79	1.45	CO_2 strong.
35	55.30	5.57	11.26	19.04	trace	3.26	5.57	CO_2 strong
36	63.71	1.60	10.50	11.83	3.98	2.70	5.60	CO_2 strong.

No.	Total Volatile.	Total Combust.	Ash.	Remarks.
33	7.97	43.34	48.69	Had been dried about three years.
34	8.03	45.32	46.65	Had been dried about three years.
35	13.43	70.96	15.61	Had been dried about three years.
39	12.37	67.14	20.49	Had been dried about three years.

Nos. 46, 47 and 48 are limestones.* They were examined for the total amount of matter insoluble in hydrochloric acid, water, iron, alumina, phosphate of iron, lime and magnesia in the soluble portion. As there was only a trace of soluble silicate and phosphates the lime and magnesia were calculated as carbonates. No. 47 gave a small per cent of alkalies, not an unusual ingredient of lime stones. Nos. 46 and 48 gave only a trace of alkalies.

*No. 46 was a sample of the common building-stone from Minneapolis—"No. 5" of the section below the University. Report for 1876. p. 149.

No. 47 was a sample of the building-stone from Taylor's quarry. near Fountain, Fillmore county, and was compact and non-argillaceous.

No. 48 was a sample of the impure limestone from Minneapolis, from "No. 1" of the section below the University. Report for 1876, p. 148.—N. H. W.

Analysis gave the following results:

No. 46.

Portion insoluble in hydrochloric acid	14.45	per cent.
Water (H_2O)	1.60	"
Ferric oxide (Fe_2O_3). Alumina (Al_2O_3) Ferric phosphate ($Fe_2P_2O_8$)	1.70	"
Carbonate of Lime ($CaCO_3$)	75.482	"
Carbonate of Magnesia ($MgCO_3$)	6.810	"
	100.043	"

Alkalies, sulphuric acid and solouble silica, of each a trace.

No. 47.

Portion insoluble in hydrocloric acid	9.890	per cent.
Water (H_2O)	0.240	"
Ferric oxide (Fe_2O_3). alumina (Al_2O_3) Ferric phosphate ($F_2P_2O_8$)	1.300	"
Carbonate of Lime ($CaCO_3$)	86.107	"
Carbonate of Magnesia ($MgCO_3$)	00.470	"
Alkalies	.440	"
	99.447	"

Sulphuric acid and soluble silica, of each a trace.

No. 48.

Portion insoluble in hydrochloric acid	16.220	per cent.
Water (H_2O)	0.375	"
Ferric oxide (H_2O), Alumina)Al_2O_3) Ferric phosphate ($Fe_2P_2O_8$)	3.075	"
Carbonate of Lime	54.533	"
Carbonate of Magnesia	36.002	"
	100.205	"

The magnesia is a fraction of one per cent too high. Alkalies, sulphuric acid and soluble silica, of each a trace.

These results would give these limestones the following values for burning into lime. If completely burned,

100 pounds	of	No.	46	would	give	61	pounds	of	lime.
"	"	"	47	"	"	60	"	"	"
"	"	"	48	"	"	62	"	"	"

Of the 61	pounds	of	No. 46,	45.5	pounds	are	available	for	mortar.
" " 60	"	"	" 47,	49	"	"	"	"	"
" " 52	"	"	" 48,	42.5	"	"	"	"	"

The mortar from Nos. 46 and 47 would be nearly a pure lime mortar, that from No. 48 would be one-third a magnesian mortar.

One houndred pounds of pure carbonate of lime will yield fifty-six pounds of lime, after burning, all of which would be available for mortar.

Practical results would vary somewhat from the above as more or less skill was exercised in burning the limestone.

No. 54. Lime Concretions found in the Brick Clay at Minneapolis.

Matter insoluble in hydrochloric acid, chiefly Fe_2O_3	4.62	per cent.
Calcium Carbonate	94.83	"
	99.45	"

There was also a trace of magnesium carbonate and organic matter.

Feb. 25, 1878.

Report on Serial Nos. 49, 50 and 51, Well Waters from Brainerd.

Ounces

C H

Al WI

Le lard

These waters are very unlike. No. 49 is a hard well water, very bad indeed from free and albuminoid ammonia. The latter might be derived from decomposing vegetation, but the free ammonia in such large quantities gives unmistakable proof, in the absence of other causes for its presence, of sewage contamination. No. 49 also contains a very large proportion of chlorine which is also proof of contamination. No. 50 is a pure well water, somewhat hard, but very free from ammonia in any form. The amount of chlorine is also small. No. 51 is harder than No. 49. It contains less ammonia than 49 but still sufficient to indicate contamination, especially when considered with the large amount of chlorine that it contains. All three of these waters contain only a trace of sulphuric acid SO_3 and a very little carbonic acid (CO_2). In waters containing so much chlorine it is useless to attempt to estimate calcium and magnesium with soap; the method of Parke's does not answer, excepting for those waters containing carbonates as I have stated in a former report.

Nothing in the appearance of these specimens would indicate that there was any difference between them or that they were unlike ordinary well or spring water.

Respectfully submitted,
S. F. PECKHAM.

MINNEAPOLIS, MINN., Dec. 11th, 1877.

P. S.—Dec. 29th. In 49 and 51 the chlorine appears greater in amount than the total solid matter. This chlorine is correct and doubtless exists in some volatile form. There was not water enough for me to ascertain to what cause the discrepancy is due, but the reason assigned above is I think adequate.

S. F. P.

X.

ENTOMOLOGY.

REPORT OF ALLEN WHITMAN.

Prof. N. H. Winchell, State Geologist:

SIR:—I have the honor to contribute to The Geological and Natural History Survey of Minnesota the following entomological notes for the year 1877. They refer mostly to the locust, with the disappearance of which we are left once more to contend only with some of the common pests of the garden, and of fruit, shade and forest trees. In this respect we are fortunate that we still lie outside of the range of some of the most pestilential enemies of the grain and corn fields; and although a persistent cultivation of any growth will probably bring in time all the insect enemies of that growth which are capable of existence and reproduction here, we are subject for the present only to the attacks of enemies not numerous in species nor excessive in number when compared with those of longer cultivated and more thickly settled States. These however are troublesome enough and are attracting more and more the attention of our horticultural and agricultural societies, as they have already attracted that of the few gentlemen in the State who have been able to devote to the study of Entomology a portion of the time largely due to other pursuits.

It is hardly the work of the Geological and Natural History Survey to furnish instruction in elementary or economic entomology. Circumstances have made it seem necessary or desirable to collect all possible information on the subject of the locust, particularly that species which has become so well known in this State of late years, in regard to which much is still to be learned, and which is still a kind of fabulous bugbear to those States which are free from it. For the purpose of completing what has already been written in previous reports, the subject is here continued. But that there are other insects in regard to whose habits, together with the best means of protection from them, our farmers and gardeners could be profitably instructed, is shown

the attention which has been paid to the subject during the past year at the meetings of our horticultural and agricultural societies, and by the (unsuccessful) attempt made in the last legislature to obtain a meagre appropriation for the purpose of issuing a pamphlet to meet the supposed need of it. It is too often the case that the inability to provide against injuries results from a lack of that knowledge of the growth and transformation of insects that ought to be in the possession of even the children in our common schools; while many pests which are practically known to every gardener while in their destructive stage, are wholly unknown to him in those stages when they are preparing to commit future injury. The State Entomologists of Missouri and Illinois (and perhaps other States,) have considered it worth their while to preface their earlier reports with brief manuals of elementary entomology. A small pamphlet of this kind with brief notices of the form, growth and habits of some of our most common species of injurious insects might be issued by the Agricultural Department of the State University (as has been done at the Agricultural College of Michigan,) and would render great service. In addition to this every one who is interested in the matter may contribute by sending to the Museum of Natural History at the State University, specimens of every kind of destructive insect, in all forms or stages of it that are capable of preservation. A collection formed in this way would in time become of great practical value, and at the meetings of the horticultural and agricultural societies at Minneapolis, would become available to a large number of persons.

Not to go outside of our cities, a large percentage of the yearly injury or ruin to our shade trees, is occasioned or increased by insects, while oftentimes the owners entertain no suspicion of the cause of the evil. We set out maples again and again, to be seriously damaged by the havoc of boring-beetles or of the Maple Aegerian, while the box-elders are defoliated and rendered unsightly by the caterpiller of an insignificant yellow moth.

Outside of the cities, in addition to the damage inflicted by the locust, the Colorado Potato Beetle has done perhaps more injury than in any year since 1870, while certain blister-beetles and the potato-stalk weevil have been more noticeable than before. While this is in writing the report of the Hon. T. M. Metcalf, Commissioner of Statistics, for the year 1877, states that the Chinch Bug has committed considerable injury in Houston county during the year. As this is an enemy to a considerable extent unknown to our farmers, I add a few brief notes in regard to it, with the hope that they may be of some value, if the evil makes its appearance again this year.

Another insect which has appeared in far greater numbers than usual during the year is the Tent Caterpillar of the Forest, (Clisiocampa Silvatica. Harris.) [Vid. Harris' Report p. 375 and Riley's Third Annual Report of the State of Missouri.] These were abundant about Brainerd, as is shown by the following :

BRAINERD, MINN., July 6th, 1877.

DEAR SIR :—I send you by express a few specimens of the army worm. East of this place they are very abundant, and the northern limit of this caterpillar is unknown. They have been observed one hundred and fifty miles north of us (by the Mississippi river) on that stream.

They eat the oak and bass wood only. In the vicinity of Island Lake on the line of the N. P. Railway, they have been very plenty, but are decreasing, advancing southward.

Yours most truly,
J. C. ROSSER.

The following extract probably refers to the same insect:

"The caterpillars have again made their appearance in large numbers in the timber in the vicinity of Eagle Lake, and are eating the foliage of the trees, in many instances almost stripping them bare. Last year they occupied the same district, covering a district from four to six miles in extent. This year they are more numerous, and we suppose are gradually extending their operations."—*Mankato Review, June 12th, 1877.*

The works referred to above describe this insect very fully, and give the means of preventing its increase.

THE ROCKY MOUNTAIN LOCUST.

The area of the egg deposits for the year 1876 will be found on the "Map of Locust Areas," in the report of the Geological and Natural History survey of that year. The statements upon which this was based came from over six hundred townships in about forty counties. The reports as to the density of these deposits varied greatly in the different counties. It was generally thought that there were very few or no eggs along the Dakota line, and in most of the territory where the young had hatched in 1876 ; that they were more numerous along the eastern line of the egg-area, where however but comparatively few appeared in the Spring ; and more numerous still in a strip of country reaching southeastward from Otter Tail to Blue Earth and including those counties, and in fact it was in this strip of territory out of all the locust region from Minnesota to Texas, that the greatest damage of the year 1877 occurred. The eggs were also thickly laid in the southern range of counties from Rock to Freeborn as well as in nearly every county in Iowa lying south of these, but all this portion of the locust region, both in Minnesota and Iowa, escaped with far less damage than had been expected, and in nearly every case with the best crops known for years.

PROGRESS DURING THE SPRING.

The locust events of the spring and summer were a succession of hopes and disappointments, ending finally in a large measure of unexpected success. The warm weather of February, followed by severe cold in March, seemed to exert in most cases no appreciable effect upon the vitality of the eggs. It was forgotten that the weather reports of March and April for the past four years would

show that the eggs are almost every year subjected to more or less freezing and thawing. When the hatching time came the young failed, for various causes, to appear in large numbers, in many places where the eggs had been laid at least as thickly as in previous years; but on the other hand they came forth in such overwhelming numbers in other places, that the unequal conditions of the different parts of the locust area, added to all the uncertainties of what the next few weeks would bring, rendered the loosely drawn and self-contradicting bounty law* of 1876 an obvious failure, and no steps were ever taken to carry it into effect. The prospect during the last ten days of May was disheartening. In thirteen counties, in parts of some and in nearly the whole of others, clean sweeping destruction of wheat and serious injury to many other crops were already in progress, while in about twenty other counties the young had appeared in sufficient numbers to cause great apprehension. From the first of June onward there was marked improvement; where the locusts were excessively numerous and where the wheat had been trimmed to the ground at that date, the crops failed to recover; but where the growth still remained or had not been badly eaten, the comparative amount of injury grew less from day to day until the crops for the most part were safe except from migrating swarms. Then followed a series of migrations in July and August, which though they added a little to the territory already injured, were so different from those of other years as to be mainly harmless. The result of all this was far different from anything which could have been expected in May, and the returns of the Commissioner of Statistics for 1878 will probably show that the locusts destroyed more bushels of grain in 1877 than have been

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GENERAL LAWS OF MINNESOTA FOR 1877; CHAPTER 86.—The act appropriates $100,000 for the destruction of grasshoppers and their eggs. The bounty is to be paid only to persons living within counties affected by grasshoppers. The sums to be paid are as follows: fifty cents per gallon for eggs; one dollar per bushel for grasshoppers caught previous to the 25th of May; fifty cents per bushel from the 25th of May to the 10th of June; twenty-five cents per bushel from the 10th of June to the 1st of July, and twenty cents per bushel from the 1st of July to the 1st of October. Instead of "caught" it would be better to use the word "delivered," for obvious reasons.

Other sections provide for the delivery of captured grasshoppers to measurers appointed (by the Governor) for each township, and for payment of bounty through certificates issued by county auditors, audited by boards of county commissioners, filed with the State Auditor, and paid with his warrant upon the State Treasurer. Although the provisions of the act extend to October 1st, the money appropriated by the act can be applied only to the payment of certificates filed with the State Auditor on or before July 15th. If the amount of these certificates exceeds $100,000 they are to be paid by the State pro rata to the amount of $100,000, and the balance in full paid by the counties according to the amounts due on certificates issued by each county. Furthermore; "no other or greater amount than $100,000 shall ever be paid under the provisions of this act."

It is entirely an unfair proportion between the price to be paid up to May 25th (one dollar per bushel, which is none too much) and from June 10th to July 1st, (25 cents per bushel,) when the locusts are in the pupa or winged state, and may easily be caught by the barrel, after nightfall. One farmer estimated the amount caught by him at this period at 400 bushels; another at 800 bushels. Besides this, it was obvious before May ended that a few of the worst infested counties would easily exhaust nearly the whole appropriation, perhaps without saving any great amount of crops; while others (which finally escaped almost unharmed without any use of the bounty law,) would have to be responsible for nearly the whole of its bounty certificates.

Other sections provide for one day's labor per week of all males between twenty-one and sixty, in the several townships of the afflicted counties, for five weeks after the grasshoppers become large enough to be caught easily; such labor to be performed under the direction of overseers of highways, who are to give notice of the time and place where it is required.

This is liable to call a man away from the defence of his own field at the very time when he is most needed at home. The same amount of labor, assessed *before the grasshoppers hatch*, in destroying eggs, or in ditching to prevent incursions, would prove far more effective.

destroyed in any other year, and that the amount left to harvest fully equalled any annual crop yet produced.

The causes of this unexpected result are for the most part a series of favorable climatic conditions. As in the year 1876 the returns of locust damage inflicted mostly in July and August, included a considerable diminution of the wheat crop by drouth in June, so, on the other hand, counties harvesting a full average crop in 1877 will probably report no damage, even where the crop was really somewhat reduced by the locusts. For once, the farmer, taking the annual chances of rain, hail, blight, drouth, insects and other destructive agencies to which he is from time to time subjected, has found the influences of climate to be so largely in his favor as to offset what otherwise promised to be an unmitigated evil, and if it is not probable that the state will be often overrun by locusts in any series of years, it is still less likely that in any one "locust-year" the hatching will again be reduced to a nullity through so large a portion of the egg-area. But that events of this kind do actually repeat themselves in the long run, is shown by the fact that the locust events of 1857 (so far as they can be recalled) are almost exactly repeated in 1877, in the thick deposit of eggs, in the character of the spring weather, in the damage which proved less than anyone had expected, and in the final departure of the migrating swarms in July and August to some unknown destination from which they failed to emerge in great numbers for several years. Of course all that is here stated of the successful results of the harvest of 1877 is said with a full knowledge of the sweeping destruction in some of the worst ravaged counties, but also with a consideration of all those counties where the locusts failed to inflict injury, and where it would have surely followed in a spring resembling that of 1876.

Other and less considerable causes tended to reduce the expected percentage of injury. These were, a certain but hardly calculable amount of destruction of the eggs by insect and other enemies, and a partial failure of the eggs to hatch, "from causes unknown;" a comparatively trifling destruction of the young by snow storms at the end of April; and, more efficient wherever applied, the destruction of the eggs by plowing and harrowing the egg-beds during the fall and spring, and the destruction of the young with ditches, tar-pans, nets, and other contrivances. To this must be added that in some cases where the young were fully as numerous as in other years they were far more harmless, and also that eggs deposited in September and October, 1876, were hatched so late that the crops were mostly beyond the reach of the young.

HATCHING.

The cases of reported hatching in February were, so far as ascertained, entirely the appearance of native species. All of those sent me were of a size that generally precluded the possibiltty of their having hatched in February. Three of our common native species were received, of which two became winged in the first week of March, but neither of the same species was observed in the fields until the 25th of May. The young (perhaps of Spretus) were seen

in our southern counties by the 10th of April, and by the 20th of the month had appeared in considerable numbers along the river bluffs between St. Peter and New Ulm. Part of these, and perhaps all, were destroyed by a storm which came about a week later, but they were only a trifling portion of all that were to appear. Innumerable newspaper items, letters, and replies to circulars show that it was not until the first ten days of May that the eggs hatched in greatest numbers, with slight difference between the dates of appearance in the northern and southern counties.

LATE HATCHING.

It was noticed everywhere that the hatching of 1877 was more prolonged than usual. This was in part due to the dampness of the spring, but more to the fact that eggs had continued to be deposited much later than usual in the fall of 1876. A case reported in 1875, when a single swarm alighted (at Waterford, Dakota Co.,) on the 18th of October and deposited eggs which did not hatch until the 20th of the following June, gives an opportunity of observing how much the late deposits are behind the early ones in the time required for hatching. Eggs left late in the season in this way wintered over in a fluid condition, which often created an impression that they were rotten, but I had no difficulty in hatching such with a three weeks' warm exposure. These finally hatched in the fields, but in most cases too late to do much injury. Their final exodus from the hatching grounds was also two to three weeks later than elsewhere, and on the 8th of July, when the locusts had all acquired wings, and had entirely left the neighborhood of Glencoe, I found, a few miles farther west in Renville county, the young in about the same stage of advancement that I had seen around Mankato on the 21st of June, from one-third to two-thirds still in the pupa-stage. But in general, where injury was severe, it was only in places where the young had been numerous as early as the last week of May, and it is only in an excessively dry year, with a slender growth of grain, that the crops are likely to be badly injured by the young that hatch after the first of June.

FAILURE IN HATCHING.

Throughout a large number of counties, and perhaps throughout the whole egg-area, a certain percentage of the eggs failed to hatch. In limited areas the failure was so great as to amount to almost complete exemption from injury. It is difficult to calculate what percentage of the eggs thus failed, but there is no doubt that it was often a large one. It is the opinion of those in Nobles county who have interested themselves in observing such matters, that eggs have never been laid so thickly in that county as in 1876, but hardly a wheat field was destroyed by the young in 1877. While this is in writing I have received brief reports from nearly every locust county in Iowa. There as in Minnesota, the hatching was in many cases far less numerous than

the extent of the egg-deposit had led people to apprehend, and in others the injury resulting from the great number which did hatch was much less than usual. The result is condensed by Prof. C. E. Bessey, of Ames, as follows : "In the fall of 1876 they (the locusts) laid many eggs in Central Iowa. In the spring of 1877 they hatched, but for some reason, not known to me, (nor any one else hereabouts,) they did not amount to much."

The causes of failure in hatching are generally stated to be "unknown." They are no doubt the unusual temperature and rainfall of the spring and the action of the Silky Mite and various grubs. It is precisely in those counties of Minnesota and Iowa where the locust evil has been most permanent for the last five years that the eggs have been apparently destroyed, while the territory of densest hatching and most sweeping destruction in Minnesota lies almost entirely outside of what has been the region of greatest and most continuous damage for the last five years. As the persistent cultivation of any growth is followed by a corresponding increase of its insect-enemies, so the increase of these insects is followed by multiplication of the parasites and enemies which prey upon them. The destroyers of the locust eggs, not endowed with the same efficient powers of locomotion as the locust itself, are confined to a smaller range and continue to multiply within it, and where the locust deposits eggs for a series of years within the same range, its enemies will in time multiply, rarely perhaps in sufficient numbers to overpower the locust, but sufficiently, when aided by other favorable conditions, to produce a marked diminution of the species; while to preserve the balance still further the locust carries its own enemies with itself to other laying-grounds not only in the germ of the slowly moving locust mite but of the swift Tachina Fly.

AREA OF GREATEST INJURY.

The greatest injury inflicted by the young during the spring, and in fact the area of all injury in the State worth reporting, was confined to a strip of country extending southeastward from about the centre of Otter Tail county to Lake Crystal, and lying along the edge of the timbered regions. On the east it was partly bounded by the timber, extending some little distance eastward into it in its northern part, (into Todd and Stearns counties), the hatching growing less as it progressed eastward, and finally failing almost entirely, except in open spots along the Mississippi. On the west the boundary was irregular. It was limited mostly by the line of what had been the most frequent cultivation in 1876, confined to river valleys and the points of thickest settlement, while as the farms became more scattered, (to the westward) the hatching thinned out and finally ended almost entirely where stretches of unbroken prairie began. In general the swarms seemed to have progressed eastward (in Minnesota) in 1876 without halting to lay except in the vicinity of cultivation, and to have been checked in their progress by the timber and to have massed their forces along its edge. At any rate this region was a laying ground through the whole of the preceding season from the middle of July, through August and

sometimes into September. It is difficult to convey, to one who has not seen such sights, an idea of the immense numbers of the young that appeared in some parts of this infested region in the last week of May. The wheat fields covered with the young, and sometimes trimmed bare of every green blade, the low bushes by the roadside stripped of their leaves, the young locusts dancing into the air, and flickering like heat in the sunlight before the horses' feet in a ride of miles across the prairies, the road-beds blackened with the young basking on the warm sand, all these, which had then hardly begun their devastating marches, prophesied the injury which was destined to ensue. These were extreme cases, but elsewhere, where the numbers were less, the bands which came marching over the fields, one after another, finally sufficed to make way with nearly every crop within their reach. Later on, the wheat which had been left by the young in May was trimmed of its green leaves, and the stalks were left like spindles, blackening in the sun, while the locusts having destroyed about every crop (except oats) which happened to lie in their path, trimmed out the tender portions of the prairie grass and made it almost unserviceable for grazing. The oats, the foliage of which was hardly touched, were attacked while heading out, and the slender stems of the berry cut off, but generally something of an oat crop was harvested when there was hardly anything else left to gather.

A general, but hardly an organized warfare was waged against the young almost from the outset, every man defending his own fields as best he could. In the nineteen counties which the Hon. Commissioner of Statistics reports as more or less injured, the acreage of wheat was less by 113,700 acres than in the preceding year, but was still considerable, amounting to 337,000 acres. Of these counties eight showed an increase of wheat-acreage over 1876, while, of the remaining eleven, four counties sowed from three to six-sevenths less than in the preceding year. There were instances of men who, warned by former experience, sowed nothing whatever, as well as of men who sowed as largely as though no enemy were at hand; but far the larger majority were the cases of those whose only hope of a decent subsistence depended on such a crop as they might bring through to harvest. The energy with which most of these began the battle as soon as the young made their appearance, was worthy of all success. The usual methods of burning the young were resorted to at once, and in some cases ditches were run about the fields. Towards the end of May the coal-tar pan, which had been used in various forms in Kansas, Colorado, and elsewhere, came at last (after having been fully described during the preceding year,*)

* the use of coal tar, kerosene, &c., in pans or otherwise or providential invention to the people of Minnesota. The ng paper was fully described in the Report of the Geolog- vey of Minnesota for 1876 a full description of the kero- in one of the "patent insides" of our country papers for Greeley, Colorado, dated August 5th, 1876, to the Farmers bes the use of coal-tar spread upon canvas, to be dragged proceedings of the Grasshopper Convention at Omaha, t was described again. In spite of all this the use of coal- an to the people of Minnesota until it was make known to m. A. B. Robbins, of Wilmar, to the St. Paul Pioneer Press

to the attention of the people of Minnesota, and was seized eagerly as an instrument that promised to be effective. For the next three or four weeks, wherever tar and sheet-iron could be obtained, men, women and children dragged the tarpan industriously over the grain fields, until the instrument became either useless or unnecessary. By the middle of June the locusts had grown so large that other means of catching had to be devised, while in the majority of cases the crops were either so badly injured as to be not worth fighting for, or were so far beyond the reach of the locusts that remained that further fighting was unnecessary. It is difficult to estimate the exact amount of success to be attributed to the different methods of destruction as they were applied, or indeed to any method that has been applied so far. In a warfare of this kind the farmer must take his chances, and what proves successful in one place, or in one year, may be totally futile at another time or place. In spite of all that has been said and written for the last three years it is necessary to say here once more what most of our farmers are at last convinced of, that in strong emergencies there is no dependence to be placed upon anything but a well dug and carefully tended ditch about the fields. If properly constructed it will prove, in nine cases out of ten, an absolute barrier until the locusts acquire wings, when the element of chance comes in again. Dr. J. C. Currier, of Mankato, managed with a ditch to save entirely unharmed the crop of 160 acres, in the midst of locusts hatching out in unusual numbers, and the method, the cost, and the result of the experiment will be found in full in the report of the National Entomological Commission; upon the Barden farm near Windom it is reported that a heavy crop was saved by a diligent use of tar-pans; Mr. Robert Lowe, of Lynn township, McLeod county, in a neighborhood where the locusts hatched in great numbers, managed to save part of a crop by using the tar-pan early in the season, and later on an open-mouthed trough, dragged over the grain after nightfall. Under the date of Nov. 21st, 1877, he writes:

"The field of wheat opposite my house yielded me 20 bushels to the acre,—the part of it which I saved, which was about 10 acres. The two neighbors of mine north of me did not fight the hoppers at all, and that part of the field next to them was eaten close. I kept working at them every night, but they got a part of it before they left.

On a three-acre field south of my house, the hoppers ate about one acre of it; they came from another neighbor that did not fight them. The two acres left yielded me 25 bushels to the acre.

The two neighbors north of me, above referred to, had about 25 acres of wheat each; one of them harvested 4 bushels to the acre, the other 3½ bushels.

I had 20 acres of new land and 5 acres of old land in wheat in another place. None of the neighbors around fought them and I did not get a kernel off that. The hoppers were more than I could handle there and on that I *did* save, so I contined my operations to that I saved. One neighbor near me who *did* fight the hoppers, saved 65 bushels from about 7 acres."

On the other hand there were fields that were swept clean of grain at the very outset. The only thing that could have saved such would have been a ditch constructed before the locusts began their march. To say that such a ditch would have proved insurmountable in every case would be to assume too much, but there is no question that it would have succeeded in a large number of cases where every other defence failed.

All this refers to protection against insects hatched outside of the grain fields. There are also large extents of wheat sown upon newly broken prairie ("new-breaking,") where the eggs had been deposited in great abundance in 1876. Wherever the deposits had been left undisturbed, the growing wheat was destroyed at the outset. Even where the surface had been harrowed or broken with the seeder in the fall of 1876, the eggs left undestroyed were still numerous enough to consume the wheat as fast as it grew. Only plowing the eggs under deeply, or vigorous harrowing of the surface in the fall or spring, with the use of a tar-pan pan to catch such as hatched upon the field, together with a ditch to prevent incursions from without, might have sufficed to save such fields as these.

INJURY TO THE CROPS.

Nineteen counties are stated by the Honorable Commissioner of Statistics to have been more or less injured in 1877. These are as follows: Kandiyohi, Chippewa, Wright, Stearns, Nicollet, Pope, Douglas, Swift, Otter Tail, Stevens, Grant, Todd, Renville, Sibley. McLeod, Meeker, Yellow Medicine, Brown, Redwood. He adds: "The most careful estimates of the bushels harvested by the counties gives the following results:

Kandiyohi and Chippewa, total loss; Wright county, slightly injured; eight counties are believed to have saved half a crop; one, a third; one, a tenth; two, two-thirds; three, three-quarters; and one, four-fifths.

This was the Commissioner's estimate in October, and it is not probable that exact statistics will *add* anything to the estimated loss. Of the above counties three were probably more injured by the flying swarms than by the young. In addition to the counties named above, thirteen others were by the end of May in a state of more or less apprehension, and tar-pans were put to vigorous use. A hot, dry June like that of 1876 would have resulted not only in greater damage in the injured counties but would have added many other counties to the injured area.

The comparative temperature and rainfall for the last four years may be seen from the following table, derived from the reports of the Signal Service at St. Paul.

	Average Temperature.		Total Rain Fall in inches.		Number of days when rain fell.	
	May.	June.	May.	June.	May.	June.
1874	62.24	68.7	1.65	11.67	7	16
1875	58.81	63.6	3.06	4.33	12	17
1876	59.2	66.3	3.15	2.02	12	14
1877	62	63.7	5.43	7.13	12	13

The total rain-fall in May was considerably greater than in any of the three preceding years, while that of June was greater than for any year since 1874. The average temperatures for May and June do not differ greatly from other years, but a detailed table would show the result of weather much better than a table of averages. It would show a well distributed rain-fall, accompanied by cold days, with northeast winds. This was the character of nearly all the former half of June. The result of this in May was a more than usually prolonged hatching, as the rain coming just when the egg-pods were bursting arrested the hatching for a time, and no doubt prevented it altogether in soils that retained moisture. Eggs thus arrested were found in the latter part of May in a decayed condition, and a prey to the Anthomyia maggot. The last two weeks of May however were warm and dry, and this gave the young insects a full opportunity for destroying the grain where they were numerous. But the change of temperature early in June again arrested their progress wherever the grain had not already been badly cut off. The large number of damp, cold, and cloudy days deterred the locusts from eating, and gave the grain an opportunity to recover itself, while the temperature was exactly such as to produce the strongest and rankest growth of wheat foliage. As this sprang up apace and covered the ground, the locusts, loving warmth and sunlight could not spread through and over the fields as in a year of slender and sparse growth, while the abundance to be eaten necessarily left more which escaped untouched. In many cases the wheat in this way attained a growth which afterwards remained beyond the reach of the locust. In others the insects were abundant enough to trim off the foliage, and in the first week of July thousands of acres of wheat stood in the fields like bare spindles, the head still enclosed in the terminal leaves. Possibly a continuance of favorable weather through July would have produced something from even such fields as this, but, in the hot, dry weather which followed, the heads never filled.

But it is to favorable temperature more than all else that we are to assign not only the abundant harvest in the uninjured counties but such crops as were saved in the remainder. Those who believe that the efficacy of our prayers may be tested by the material results which follow them, can safely find a beneficent answer to the fasting and supplication of April, not in a brief snow storm that perhaps destroyed an insignificant number of locusts which would in all probability have proved harmless, but in a whole season of favoring winds and nourishing rains.

The effects of climate were seen too upon the young insects as well as upon the grain. It is to this doubtless that we are to assign the cause of the often reported disappearance of the young in the spring without committing injury, and of the harmlessness, "from causes unknown," of such as remained up to the time of flying; reports which come from Iowa oftener than from Minnesota. It is to the same cause no doubt that we are to attribute the number of locusts found dead in the fields during the spring; numbers which were very inconsiderable when compared with those which remained alive, but sufficient to show that unusual agencies were at

work. To those who from limited observation believe that the species is proof against moisture, it may be asserted that a spring of a different character from the four preceding has been followed by an unusual series of locust events, viz.: comparative harmlesness of the hatching brood, a partial degeneration, and finally a total migration as if from an unnatural neighborhood; while still others are to be reminded that the State is no more a permanent breeding ground of the species, and no more likely to be, than it was some years ago.

MOVEMENTS OF THE WINGED.

Here and there a fully winged individual of Spretus may be found in our fields early in June. I noticed such on the 8th of June, 1876, and on the 14th day of June, 1877, while others were reported as early as the 26th of May. From the middle of June the number of the winged increases rapidly, and these often rise in the air singly, and float lazily along on the breeze. On the 19th of June I observed such at Mankato, as thick in the air as stars upon a moderately starry night, while upon the ground below a still greater number had developed wings, and on being disturbed would start up for a low flight of a rod or two. Here and there one would rise from the earth, and could be seen rising very gradually in the air for a long distance, until it finally became lost to sight. Neither on the ground nor in the air was there any appearance of swarming. The numbers in the air increased rapidly from day to day until the last week in June, when, as if they had begun to mass their forces, dense swarms could be seen moving slowly, high in the air, over the central portion of the State. These, though appearing to move southeast on the 26th, 27th, and 28th of June, were not seen east of what had been the hatching area. From the latter date until nearly the middle of August the State was repeatedly crossed and recrossed by immense bodies of locusts, alighting heavily and destructively in the first week of July, but only appearing high in the air, and purely as migrating swarms later on. These movements consisted generally of bodies, (rather than of one immense swarm,) seen here and there over a large area, all pursuing one general direction, and following each other for a few days until the supply seemed exhausted, when, after a change of wind, what were apparently parts of the same army, returned over their former track only to be carried back again with others when the wind changed back again. As the season advanced, the swarms making up these armies became more scattered, and followed each other at wider intervals, or were soon separated at long distances from each other.

MIGRATIONS.

These movements may be briefly summed up as follows:

July 3d–7th—A movement to the northwest by daily journeys, with heavy alighting each evening from Willmar westward to the Sisseton Reservation and beyond.

July 8th–10th—A change of wind, with a return at once to the southeast. This movement was observed at sixty points between Bramble county, D. T., and Freeborn county on the south, and between Otter Tail and Sherburne counties on the north.

July 11th and 12th—A change of wind and return of the swarms to the northwest, observed at various places between Detroit and Sioux City on the west and between Sioux City and Fort Randall, D. T.

July 20th and 21st—An immense movement to the southeast again, observed at 78 points in Minnesota and Dakota. Swarms were seen on the western line of observation, at various points between Walhalla and Rockport, D. T., 375 miles from north to south, and between Rockport and Albert Lea, on the southern line, 225 miles from east to west.

July 28—Another movement to the southeast, seen over various northern and southern counties, but not reported over a large number of intermediate points.

August 1st and 2d—Another extensive movement to the southeast. This was seen at various points between Glyndon and Luverne on the west, and at St. Cloud, Anoka, Northfield and LeRoy on the east.

Aug. 6th–9th—Heavy flights, (but decreasing in numbers daily) to the southeast again ; seen mostly on a line between Benson and Mankato and Worthington.

Sept. 2d—"Large numbers" flying southeast over Waseca.

Sept. 18th—"Millions seen flying in a southeasterly direction" at Long Prairie.

There is reason to believe that, as has been known elsewhere, many of these swarms continued their flights through the night. They were observed on several occasions flying till nearly sundown, while it was impossible to learn of their alighting anywhere at or during the night ; they were seen moving early in the morning as soon as the sun was high enough to make their numbers visible, while there was no known starting place from which such swarms could have proceeded so early in the morning ; and in one known case, (and probably in many others,) they abandoned in the night a spot where they had been abundant during the day.

It will be noticed that after the 20th of July all extensive movements were to the southward. On the dates intermediate between those given, there was a change of wind to southward, and this carried back sometimes considerable, but always scattered bodies to the northwest, while as the season advanced the number thus carried back became fewer. Those which were carried to the northwest probably helped to make up the bodies which moved southeast again as soon as the wind changed to northerly, and what may have been something like a compact army early in July were spread over a large territory later on. The change of wind between the 7th and 8th, and again between the 10th and 11th of July were followed at once by the return of swarms over the track where they had passed the day before ; on the other hand it required a change of wind from the 12th to the 20th and again from the 20th to the 28th

of July to collect and bring back the swarms which passed over on the latter dates. During the later movements too, straggling bands were seen at a considerable distance to the east of the main bodies, as at St. Paul on the 20th of July, on the 1st and 2d of August at Anoka, St. Paul, Northfield and Leroy, on the 6th of August at Hastings, Dundas, and Brownsdale; and during August and September over El Paso, Wisconsin, and over Osage, Grundy Centre, Toledo, and Montezuma, aud perhaps over Waverly, Waterloo, Oskaloosa, and Vinton, Iowa, all of which points lie considerably to the east of the usual locust area.

All the movements after the 10th of July were purely migrations. Here and there individuals dropped down from the passing swarms until a township or two was pretty well covered, but as a rule the insects passed over without alighting. To determine the migratory capabilities and habits of the locust would be interesting and useful. During the summer I collected nearly a thousand reports, diaries, &c., to learn the extent of the flights over Minnesota. The impossibility of obtaining similar reports from Central Dakota, and the absence of such from Iowa, render it difficult to trace movements beyond the State line. The turning point of flights between the 7th and 8th of July was evidently in the neighborhood of the Sisseton Reservation; between the 10th and 11th, either in or over Iowa; about the 22d of the month the swarms collected in Dakota along the route between Bismarck and the Black Hills and these were perhaps brought southeast again on the 28th of July.

It seems probable that most of the swarms seen passed to the southward of Minnesota and remained there. It is certain that the bodies composing the different migrating armies became widely separated from each other during the season, and it is highly probable that the individuals composing these bodies were distributed over a large extent of territory and often so sparsely as to remain almost unnoticed. By the first of September the species was found at Sioux City and Fort Dodge, Iowa, in small numbers, but more numerous than the native species; still more numerous at Ackley, where they were preparing to lay; again in very small numbers at two or three stopping places along the road between Ackley and Lyle, at Lyle and at Austin; and a few days later at Lake Phalen, five miles northeast of St. Paul. It is very likely that a careful search in 1878 by those acquainted with the species will disclose the presence of the young in very small numbers at various places in Eastern Minnesota, in Wisconsin east of Hastings, and in Eastern Iowa.

The locust evil being ended for the present, all further consideration of the matter produces in the mind of the farmer only that disgust which is excited by an unpleasant subject. But the time will come again when the possibility or likelihood of locust invasions, and whether they can be anticipated or prevented will be questions of immediate interest. But to a community looking forward to years of prosperous wheat-raising, and knowing that future success depends in some measure upon exemption from various insect plagues, it should seem foolish to conclude the inquiry with that amount of knowledge which has so far been obtained. The National Entomological Commission should be enabled to

pursue its investigations beyond the field where circumstances have so far confined them, into the region where the nature of the locust problem is still largely unknown, and where alone the possibilities and probabilities of future destructive incursions are to be calculated.

DISTRIBUTION.

A history of former locust invasions, and a full chronology of locust appearances in past years, whether seen in small or in great numbers, in destructive onslaughts upon the grain, or in harmless migrations to other neighborhoods, become valuable to assist in determining what are the regions of perpetual, frequent, or occasional presence. It has been common to call "locust years" only those years in which swarms have appeared in destructive numbers, and to call "locust regions" and "grasshopper counties" those only where cultivation has been sufficient to invite injury. It has often been difficult to collect such facts as there are, and the desire to appear well in immigration statistics induces men to withhold occurrences that would seem to convert their particular localities into "grasshopper regions" for the time being, but which were after all only trifling appearances of a misfortune that was felt elsewhere in full force. "Locust regions" are not created by simple statements of facts, nor are the gardens of the world depopulated by occasional locust invasions.

But a locust chronology for the past fifteen years contradicts the notion that there is anything like periodicity in the appearance of the species, though there are evidently years or periods of excessive multiplication; it also disposes of such vagaries as that the stock has been advancing eastward yearly, occupying a certain belt of country each year; or that they "move mostly in a great circle, touching Missouri on the east, and New Mexico on the south, the Pacific on the west, and far into the British Possessions on the north," the time required for swinging around this circle "being about ten years, though some get behind by being hatched out late!" It has been a locust year somewhere or other nearly every year for the last fifteen years, and swarms have repeatedly swept southward from British America perhaps to Texas, while their offspring moved back northward over the same track in the following spring. It would seem that east of what may be the permanent breeding grounds of the species, there is a region where swarms appear nearly every year, and that the permanence or frequency of appearance diminishes as we move eastward. To say that this region of frequent appearance is not a "grasshopper country," is to say for the present that it is mostly uncultivated and uninhabited, though there is no reason to believe that if it were under full cultivation that it would suffer devastation every year.

This region of frequent appearance reaches eastward nearly to [illegible] Minnesota, and the frequency results from the fact [illegible] the region referred to lies in the track of swarms moving nort[illegible] towards the mountains in the spring, southeastward [illegible] mountains in the summer, and at the same time in the vic[illegible] swarms occasionally hatched upon the plains. At least it is ce[illegible]

that the locust has been seen either along or east of the western border of Minnesota nearly every year since 1863. At Walhalla, a few miles west of Pembina, they are said to have come one year and left in the year following ever since in the year just named; in the same year (1863,) they were about Moorhead, around the Coteau des Prairie, Ft. Abercrombie, and were seen flying as far east as the Pomme de Terre River; in 1864 the young hatched near Moorhead, and possibly in other places in the western part of the State north of the Minnesota river; while in July winged swarms from the west made their way in a narrow column up the Mississippi Valley to Le Sueur and Henderson; in 1865 the young of these were troublesome in the regions just named; in 1866, a year of serious invasion in States to the southward, there were but slight and transient appearances of swarms in Minnesota, about Moorhead, and in Redwood and Kandiyohi counties; in 1867, a year in which Iowa was overrun almost as extensively as in 1876, there was no appearance in Minnesota so far as can be ascertained; in 1868 large swarms passed northward over Jackson county for two or three days, probably those which had hatched in Iowa and the States below; in 1869 the insects were seen about Moorhead again; in 1870 about Moorhead and in Brooking Co., D. T.; in 1871 a large number of our northwestern counties were visited, but were injured only here and there; in 1872 the offspring of these augmented by others hatched in Dakota seemed to have passed southward in immense armies over Southeastern Dakota and Nebraska; the events since 1872 are too well known to need repeating.

There is nothing alarming in these statements; it is known well enough in how few of all these years the insects have poured into the State in immense swarms, and how few of all the swarms that have appeared have remained to prove destructive. It is only in a year of excessive and repeated visitation that the small numbers remaining behind from each passing cloud finally become numerous enough in the aggregate to make their presence destructive in the year following. It is only meant to show that Eastern Dakota lies in or near a region where the locust frequently appears; somewhere within yearly reaching distance of the transient or permanent breeding grounds of the locusts. On the other hand but a few miles to the east lies a region where the locust appears but rarely, while still a short distance beyond is a region where it never appears.

A line drawn from Crookston to Le Sueur, thence southward across Iowa through Fort Dodge marks nearly the general eastern limit of serious injury. In Minnesota this is nearly the dividing line between the prairie and the timber, which in Douglas and Otter Tail counties extends some thirty miles to the west of the line though not densely everywhere. From Le Sueur southward the line again coincides very nearly with the western boundary of the Big Woods, until the latter, thinning out give place to the prairie [illegible]ties of Southern Minnesota and Iowa, where as the physical [illegible] of the forest no longer exists, the line must represent nearly [illegible]ural limits of the encroachment of the species. That there [illegible] such natural eastern limit, coinciding nearly with the line [illegible]

given, is seen from the fact that the hatching swarms, on migrating, have on no occasion whatever occupied new ground to the eastward, or pursued any line of flight which would not carry them somewhere to the west of where they hatched. Whenever invasions have been carried to the east of the usual line, it has been in all cases by swarms appearing from the northwest, generally late in the season and by slow advance.

These in exceptional cases have occasioned injury or have deposited eggs in the openings to the east of the limits named, but with serious results only in 1856 in the Upper Mississippi Valley, and in Todd and Stearns counties in 1876.

To determine exactly how far east the species has hatched of late years, and to say just where it definitely ended, would have required careful examination by those acquainted with the species. It hatched in 1877 in observable numbers at least fully up to the line given upon the "Map of Locust Areas," in the report of the Geological and Natural History Survey for 1876. The hatching of the year confirmed the general correctness of this line; still more correctly it might have been drawn from Detroit to Princeton, thence southward to Austin, whence it moved southward across Iowa, passing nearly through Hardin, Story, Dallas, Madison, Adams and Taylor counties. But throughout all the eastern portion of this hatching area the young appeared in squads on scattered hatching grounds, and no doubt careful search might have found still others east of the limits given, the young of the swarms straggling eastward late in the fall, and finally disappearing, no one knew where.

It would be interesting to learn also the extreme northeastern limit of the appearance of the species. It lies somewhere in a region of woods and swamps north of the Northern Pacific and east of the longitude of Brainerd. This almost uninhabited region, though not lying in the usual line of flights, might be traversed by swarms in almost any summer and the fact remain unheard of. It is certain that locusts in years past have been seen in swarms, or in small numbers on the ground, at Red Lake, Leech Lake, Gull Lake, Brainerd, Aitken and Duluth, while several years ago locusts injured the vegetables and grass upon the island opposite Ashland, Wisconsin. All these points lie in a region which the locust is supposed to avoid. But even if it is possible for this insect to choose by instinct a certain line of flight, and to select the winds which will carry it in that general direction, it is carried at times to situations which the most trifling amount of instinct would cause it to shun, and has been found in immense numbers in the waters of Lake of the Woods, Red Lake, and in fewer numbers in Lake Superior. The northeastern limit of flight depends, partly at least, upon the point where swarms cross our border, and those coming in well to the east on the Manitoba line might, as in 1856, be carried into the Upper Mississippi Valley. The swarms of that year were no straggling bands, blown out of their course late in the season, but came in immense numbers, which by the testimony of all who remember the event, were many times more numerous than any that have appeared in later years. These reached Gull Lake and the region around it near the end of July, and not only destroyed the

crops at Crow Wing and thence southward in the Upper Mississippi Valley (which has never since been injured between Crow Wing and Sauk Rapids.) but penetrated in monstrous numbers into the woods about Mille Lacs Lake where they bent down the pine branches with their weight. They penetrated in considerable numbers as far as Cambridge, Isanti Co., a point which was hardly reached by swarms of 1874, and was not visited in 1876. All those swarms of 1856 must have crossed the northern boundary well to the east, or must have turned their flight eastward over the very regions which the locust is supposed to avoid. It is also noticeable that they penetrated southward only to about the neighborhood of Shakopee.

This was an exceptional instance in some respects. and in the locust invasions which we are destined to suffer in the future, there will probably be occasional events which will seem to contradict all previous experience, and to make it impossible to lay down anything like general rules. It might happen that swarms in a long, warm, and dry autumn might pass a few miles farther east than they have ever appeared before, and leave eggs which in a following spring of excessive dryness, and with a thin growth of grain, would prove destructive to a large proportion of everything sown. For all that the species has a certain natural range, and though no line can be definitely drawn beyond which it can be predicted that the locust will never appear. the regions of habitual, frequent, and infrequent appearance will be ascertained, while there still remains the strong probability that with increase of cultivated acreage towards the mountain regions the appearance of swarms in Minnesota will become rarer than before. It may even become possible to predict the time of appearance at certain points, and to take an example, as swarms reached Sauk Rapids about Aug. 20th. 1856, Aug. 17th, 1874, and Aug. 11th and 18th. 1876; as they reached Monticello Aug. 13th to 16th. 1856. Aug. 17th, 1874, and Aug. 18th, 1876, it is not probable that they will often reach the Upper Mississippi before the middle of August, or will often prove destructive to any great distance beyond it, either in a summer of invasion or in the spring following.

Finally, if there is in future any fear that Minnesota may become a permanent breeding ground of the locust, it may be said that so far as is known there is no permanent breeding ground of the species in any strict sense of that term. The species is migratory, and until it loses this habit there is no fear that the swarm which hatch here will remain to breed by natural increase. They may remove but partially, or to a short distance only, or they may be replaced by others in the same season, but in any case the instinct, the impulse, or the chance wind which brings them upon us will eventually remove their offspring.

The reference on the 2d page of this report to damage inflicted by the Chinch Bug may be found on pp. 17 and 18 of the Report of the Commissioner of Statistics for 1877, as follows:

"The crop of 1876 was menaced by three destructive agencies. The one already mentioned—heat drouth or whatever it was; the dreadful locust, whose flickering wings filled the air in the western portions of the state from the earth to the highest point of human vision; and locally, in Houston county, the chinch bug, where considerable damage was inflicted by this new foe to our great staple.

* * * * * * the third was not of sufficient magnitude to warrant the precise ascertainment of it—but it is a dangerous and insidious foe, and doubly dangerous because it is insidious, and should the coming year be marked with their renewed attacks, they should be carefully studied and their characteristics reported."

Upon page 97 of the same report the Commissioner quoted the following letter:

CALEDONIA, HOUSTON CO, MINN.
December 10, 1877.

T. M. Metcalf, Commissioner of Statistics:

SIR:—In reply to your inquiries as to the ravages of the Chinch Bug in this county, I cannot say much.

These pests are a mystery to me, and to every one of whom I have inquired, and I have not been able to find out much about them.

They are here now; they have charged the earth with eggs ready for the hatching temperature of earliest Spring, when, I fear, our farmers here will catch it again. I learn that they are at Fountain, on the Southern Minnesota Railroad, in myriads.

It is estimated that they destroyed two-fifths of the wheat crop of this county in 1877.

The *bee theory* has been tried on them. They smell like a bed-bug, and one can detect their presence by the smell in walking through the fields. They also manifest themselves by the change in the color of the grain. Their season is when the grain is in the "milk," just before harvest.

They do no injury at all before that time.

It is said that they were here before—just at the close of the war. Some of them live in the ground, under the stools of the grain through the winter, but most of them leave their eggs and die in the fall.

They work in a small patch, and all that are in that patch get together at night in a large pile, like ants in a hill, and the boot-heel, and hot water, with aid of lanterns, are used; but this is a slow process. When they finish a small patch, they move to another part of the field.

They were not troublesome in the western part of this county, nor were there many, if any, in adjoining counties.

Very Respectfully,
Yours, &c.,
E. W. TRASK,
Auditor of Houston Co,

I have received the following letter from the same source :

DEAR SIR:—Your favor of the 19th inst. requesting information concerning chinch bugs, rye, &c, came duly. The chinch bugs promise mischief again this year in this county. They are very thick in the fields. We are a little in hopes that frequent cool showers will keep them back, and the early season ripen the grain before they do much damage. Some, not much, winter-rye is sown. The bugs do not trouble that much I am informed.

Respectfully,
E. W. TRASK,
Auditor of Houston Co.

CALEDONIA, MINN. May 22, 1878.

Crop reports in the St Paul Pioneer Press during the past month mention the presence of the chinch bug in other localities. As it may be necessary for farmers to take what precautions they can against this most dangerons insect, I here briefly digest the substance of several entomological reports upon the chinch bug, with the hope that the republication of these notes in the newspapers may add something to the knowledge of those who are not practically acquainted with it. Riley's Seventh Annual Report for the State of Missouri (pp. 19-50) describes (with figures) the insect in full, its habits natural enemies, and the best methods of contending with it. Fitch's 2d Entomological Report for the State of New York. Harris, Insects injurious to Vegetation, and Prof A. S. Packard's Report on the Locust and other Insects in the western States and Territories contain interesting and valuable information on the same subjects.

THE CHINCH BUG.

Mentioned in various agricultural and entomological reports under the scientific names of *Lygaeus Leucopterus, Rhyparochromus Leucopterus, Micropus Leucopterus, Blissus Leucopterus.*

An hemipterous (half-winged) insect of the sub-order of *Heteroptera;* emitting, like many insects to which it is related, and for some of which it is easily mistaken, a nauseous (bed-buggy) odor.

A sucking (haustellate) insect, furnished with a sharp-pointed beak, subsisting upon the juices of grasses and cereals. Found while young feeding upon the roots and afterwards upon stalks and leaves.

The adult insect is about three-twentieths of an inch in length; the body is long, blackish, and hairy; the wings and fore wings are white, while the latter have a black spot upon the middle of the edge; legs dark yellow. Some ten varieties (including one wingless) are found differing more or less in color, but in general the species may be easily distinguished by the white fore wings with the black spot upon the edge.

The adult insects pass the winter hidden about the edges of fields, "under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass, or weeds or straw, and often in cornstalks and cornshucks.—*Riley.*

These come forth in the warm spring, pair, and the female deposits her eggs, laying them from day to day for about twenty days, underground upon the roots of the plant destined for food. These are laid in clusters, and are about three one-hundredths of an inch long, and pale amber-colored. They hatch in about two weeks, and the wingless young, bright red in color, may be found around and clinging to the roots where they have been hatched. These acquire wings in about six weeks, and after pairing, produce a second brood which lives through the winter, as stated above.

The insects may be seen upon the wing at pairing time, but do not take to flight readily. Their migrations are performed mostly on foot, in the growing stages, and from one field to another.

For the purpose of destroying the adult insects in the fall and winter, and to prevent future multiplication. the corn-stalks, dry weeds, rubbish, &c., about the fields, should be burned, or these with boards, or anything under which the insects may take shelter, may be left around the fields, for the purpose of trapping them.

As the female endeavors to penetrate below the surface of the ground for the pupose of depositing her eggs about the roots of plants, rolling after seeding tends, by hardening the ground, to prevent the deposit of eggs.

Early sowing and invigorating the plant with manure tend to bring forward the crops before the young are capable of doing their greatest injury.

As Hungarian grass is a favorite food of the chinch bug, a rod or two of it sown around a field of wheat tend to keep the young occupied until the wheat is out of danger. It is also recommended to sow with each 12 bushels of winter wheat one bushel of winter rye, as the bugs will destroy the rye in preference to the wheat: or to surround or intersperse grain crops with hemp, flax, castor beans, or buckwheat. Whenever badly infested patches of grain are noticed early in the season, straw should be spread over them and burned.

The migrations of the young. on foot, are prevented by boards set on edge along fields, and smeared with tar; or by coal tar poured along on the ground; or by running along the edge of fields a furrow turned outward, in which the insects may be destroyed by dragging, burning, or in pit-holes.

Excessive moisture, (rain, etc.) are destructive to the chinch bug: hence wherever continued irrigation is possible the insects may always be destroyed while still underground.

Among the natural enemies of the chinch bug are several species of Lady Bird, the Insidious Flower Bug, and the many-Banded Robber. (of insects), and the quail, as well as (perhaps) the prairie-chicken and red-winged black-bird.

As before stated, many insects closely related to the chinch bug, having nearly the same form and smell. may be easily mistaken for it. Perhaps the most common of these is the False Chinch Bug (Nysius Destructor). [I found these in abundance (pairing) around Monticello, June 14. in cornstubble and around purslane ; they were mistaken for the chinch bug by those who had seen the latter repeatedly].

The chinch bug is a southern rather than a northern species of insect, but it has been found in Wisconsin considerably farther north than in Minnesota, and Prof Packard has found it in Maine and on the summit of Mount Washington. He infers that it is found in the colder as well as warmer portions of New England, and adds. "It probably inhabits the entire United States east of longitude 100°, and will probably occur in the western Territories, wherever wheat is raised, though perhaps the altitude and peculiar climatic features of the Rocky Mountain Plateau may prevent its rapid and undue increase."

It has years of excessive multiplication, like the locust, and other insects. In 1864 it was exceedingly destructive in the Mississippi Valley. In 1868 it did considerable damage in Southern Illinois and Southwestern Missouri. In 1871 and 1874 it was again very destructive—in the former year the losses were estimated at thirty, and in the latter at sixty million dollars, the losses in Missouri alone amounting to ninteen millions. (Riley). In such years as these its control passes beyond the hands of man, and it is only possible to mitigate its ravages to some extent, by earnest and united efforts.

Respectfully submitted,
ALLEN WHITMAN.

XI.

ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

Prof. N. H. Winchell:

DEAR SIR:—In accordance with your request I have the pleasure to report a satisfactory advancement of the ornithological survey of the State during the past year. Personally, and through the assistance of competent observers, representative localities remote from the settlements have received special attention, particularly those embracing water-courses, and heavily timbered districts. Many important facts pertaining to the migration, distribution, feeding, and breeding of some species about which hitherto very little has been known, have been obtained which will be valuable in the further prosecution of the survey. Another of these facts, notably, is the intermixture of varietal forms representing different avi-faunal provinces. The western borders of the State have long been known to be interchangeable grounds, but it appears that most other portions partake of the same characteristics. I merely allude to these things to indicate to you some features of the work to be accomplished. If it were only the listing of species found to be what is commonly called *resident birds*, my previous work, together with my co-laborers in the Minnesota Academy of Natural Sciences, would leave comparatively little to be done. But it embraces the largest measure of attainable data in everything pertaining to the esthetic and economic relationships of the birds to the commonwealth.

To accomplish so much, or to approximate it necessitates the employment of all available aid and considerable time. I regard myself highly favored in having the co-operation of several competent collectors in the different sections of the State and especially a number of young men residing in this city. They have alread contributed notes on the habits of some rare species that ar

great value which will appear in my final report, when each will be duly accredited with all that he has done.

With this abbreviated general statement of what I have accomplished during the year, reserving details for a final report, I remain

Yours respectfully,

P. L. HATCH.

818 Nicollet Avenue, Minneapolis, May 1, 1878.

XII.

RAILROAD ELEVATIONS.

BY E. S. ALEXANDER.

ELEVATION on the Hutchinson branch of the Minneapolis Northwestern Railway—Commencing 11.6 miles west of Minn apolis, on the line of M. & St. L. Railway, thence westward through counties of Hennepin, Carver and McLeod, to Hutchinson—from notes of preliminary survey made in November, 1877.

Miles from St. P.&P. Ry Depot.		Elev abo Oce
11.6	Island Lake (M. & St. L. railway track)	
	" " (surface of water)........	
12.2		
13.4	Town-line between Eden Prairie and Minnetonka townships 1½ miles east of northwest corner of E. P. township (ground)	
	Bottom of Purgatory creek........	
15.6	Town-line, Minnetonka and Excelsior townships, ½ mile north of township corner (ground)........	
15.8	Opposite north end of Silvine or German Lake (water—about)......	
16.9	Summit of ridge between Silvine and Christmas lakes........	
17.1	Ridge south of Christmas Lake........	
	Christmas Lake (water—about)........	
18.2	Lake Lucy (ground)........	
	" " (water)........	
19.3	On west line of section 3 near ¼ corner Chanhassan township. This is on a narrow ridge 15 feet above the tamarack swamp on west, and 20 feet above tamarack swamp on east; the hills on each side are sixty or seventy feet higher than the swamp........	
20.0	Minnewashta Lake (water)........	
20.7	North line of Chanhassen township, in front of school house No. 59	
21.8	Virginia Lake (water)........	
22.7	Outlet of Virginia Lake—head of Lake Minnetonka—old site of Smithtown (water of Minnetonka)........	
	From here the line follows around the south side of Lake Minnetonka and Halsted's bay to 26.2 miles. Bluffs are from 80 to 100ft. high.	

t.		Elevation above Ocean.
	Ridge between Six-mile creek and Halsted's bay	943
	Marsh of Six-mile creek	919
	Six-Mile creek (bottom)	913
	500 feet north of the center of section 20, Minnetrista township—outlet of large cranberry marsh	973
	Watershed between Lake Minnetonka and Crow river	981
	On south edge of Picture or Mud Lake (water)	929
	Center of section 14, Watertown township	931
		983
	Crow River (bluff on east side)	965
	" " (Watertown mill-dam)	916
	" " (bottom of river)	910
	1,900 feet north of southwest corner of section 8, Watertown Tp., (grassy swamp)	926
		981
	Ocean Marsh (grassy marsh)	988
	County-line between Carver county and McLeod	1,014
	Outlet of Winsted Lake [dry bottom]	981
	Winsted Lake, south side [top of bluff]	1,003
	" " [water]	985
		1,026
		1,029
		1,048
		1,040
	1,400 feet west of the southeast corner of section 28 in Hale township—half mile north of Silver Lake post-office	1,051
		1,074
	Swan Lake [water]	1,036
		1,066
	Bear creek	1,037
	Leave Big Woods and enter the rolling prairie	1,058
	Crow River [bluff]	1,068
	" " [water]	1,020
	" " [bottom]	1,017
	Hutchinson	1,033

e above levels do not give a correct idea of the nature of the ry—which is very rough as far as Watertown.

m 12.5 miles to 15.8 miles the line follows the valley of Pur- y Creek, whose bluffs roll back to a height of about 70 feet in er of a mile.

17.0 miles the line crosses a ridge which runs northeasterly outhwesterly. This ridge, compressed to a width at the base 0 or 600 feet between lakes Silvine and Christmas, widens out southwest and northeast. It prevents Lake Minnetonka from ing into Purgatory creek—although that valley is nearly forty ower than the lake—and flowing thence into the Minnesota

e bluffs on Lake Minnetonka rise abruptly to hight of about et, and a few hundred feet back are 100 feet above the lake. ine runs around on the foot of the bluffs.

om Six Mile creek the line follows up a small valley to 29.2 where it crosses the watershed. At this place there are hills ch side which must be 80 feet higher.

om here it follows down a small ravine between high hills to re Lake. On the north, south, and northeast sides of this lake ills rise abruptly about one hundred feet.

From here to Watertown the country is not so broken.

From 36.5 miles the line follows up a small valley—whose bluffs are about 40 feet high—to 39.9 miles.

From this point to Hutchinson the general level of the country is very well shown by the table. It is rich and rolling, the knolls rise ten, twenty, and sometimes thirty feet above the depressions.

[The red hardpan drift, in a modified condition, extends *via* Hopkins Station, past the east end of Lake Minnetonka, and to within perhaps five or six miles of Excelsior. The drift knolls that seem to extend in a nearly continuous series along the south side of the Lake Minnetonka consist of this red drift. There are occasional places of sandy surface, and others of red loam, but the most of the surface is of a red gravelly loam that seems to be derived from a slight mixing of the gravelly sub-soil with a thin loam that probably corresponds to the loess loam of further east. On these knolls the soil is the same, but is much thinner, or almost destitute of loam.

On the road to Wayzata, from Minneapolis, the red drift continues to the Half-way House about seven miles from Minneapolis. Thence westward, along the north side of Lake Minnetonka, the surface is one of gray hardpan. N. H. W.]

XIII.

REPORT ON THE GENERAL MUSEUM,

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY FOR THE YEAR 1877.

By N. H. Winchell, Curator.

The principal work during the year has been the opening, cataloguing, and placing on exhibition of the Kunz collection of minerals. On the completion of the twelve cases designed for minerals and fossils, which are constructed on the plan of similar cases in the Smithsonian Institution at Washington, these specimens were deposited therein. They were subsequently re-handled and neatly labeled with a form of printed label. In the same cases have been placed a part of the fossils of the Trenton formation which have been studied. The duplicates of the species of the Kunz collection, which constitute nearly one-half of its bulk, have also been examined, recorded in the register, and re-boxed. They will shortly be offered for exchange, and in that way will serve to increase the number of species in the Museum.

The *Megatherium* skeleton, a part of the collection purchased of H. A. Ward several years ago, was unboxed for the first time since its delivery at the University, in the summer of 1877, and carried to the north room of the Museum preparatory to mounting. Unavoidable circumstances, much to be regretted, have delayed this to the present, and the room, on the floor of which it is spread out, has necessarily been closed to promiscuous admission of the public, though interested visitors have been admitted on application.

Two other upright cases have also been built in the north room, uniform with those reported last year, designed for the exhibition of birds, thus furnishing the walls of the room with all the cases they will accommodate. In one of these cases Mr. Herrick has placed a number of our native birds, tastefully and naturally

mounted, and arranged on artificial supports. The ornithological observations of Mr. Herrick during the year have been reported to Dr. Hatch, for use in preparing a final report on the ornithology of the State.

In addition to the birds added to the Museum, a number of plant-specimens have been preserved by Mr. Herrick; and others have been presented by Mr. B. Juni.

The fossils collected from the Trenton limestone at Minneapolis are mostly entered in the Register, though as yet unstudied.

A collection of marine specimens from the coast of Virginia was presented by Ex-Governor Horace Austin, comprising the following species:

1. Flying Gurnard. *Perinothus* (sp?)..........................1 specimen.
2. Weak Fish. *Otolithus regalis. Cuv. and Val*..............1 specimen.
3. Toad Fish. *Batrachus tau. Linn*..........................1 specimen.
4. Perch. *Perca* (sp?)..................................3 specimens.
5. Fiddler crab. *Gelasimus vocans. Milne Ed*................1 specimen.
6. Crap. *Lupa* (sp?)...................................5 specimens.
7. *Brachyuran crustaceans*................................3 specimens.
8. Sea Urchin. *Echinus* (sp?)............................2 specimens.
9. Brittle Star. *Ophiura* (sp?)...........................1 specimen.
10. Star Fish. *Asterias* (sp?)............................2 specimens.

These have been placed in suitable bottles in alcohol, and form, together with other specimens collected in the Custer Expedition to the Black Hills in 1874, and others preserved last year, the nucleus of a collection of the invertebrate and lower vertebrate animals which will be of much interest.

A specimen of the so-called Jack Rabbit was obtained at Lake Shetek in Murray county, where was also found the common eastern species. This is probably nearly on the eastern limit of the range of the Jack Rabbit. A few skulls are mounted on suitable pedestals, viz.: *Ovis*, *Canis*, and *Felis*, to which others will be added.

The following catalogue shows the name, number, and source of the geological and mineralogical specimens added during the year, exclusive of the collection of several boxes in the prosecution of the field work of the Geological Survey, and only so far as the same have been examined and labeled.

CATALOGUE OF SPECIMENS REGISTERED

in the General Museum in 1877.

Serial Number.	Obtained. When.	Obtained. Whence.	NAmE.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
90	....	Dr. Stoneman.....	Asaphus extans. H. Compare 399..............	1	....	Trenton...	Has tuberculated surface in-[stead of lamellose.
172	Oct. 1872	Geol. Sur..........	Block with schizocrinus nodosus. H. Murchisonia. sp. ? and the head of a trilobite....	1	Pleasant Grove, Olm Co.	" ..	N. H. Winchell................
185	1875.	"	Slabs containing Strophomena. (Specimens. Orthis Chetaetes *et al*.........	1	Fillmore Co............	" ..	" ....
186	"	"	Orthis perveta. Con. (Larger than the type.	4	Fount'n in Fillmore Co.	" ..	" (Taylor's Quarry)
189	"	"	Fragments of Asaphus gigas. H...............	1	Fillmore County........	" ..	N. H. Winchell.................
191	"	"	Slab with Leptaena sericea. Sow. Orthis emacerata. H. Strophomena filitexta. H. Strophomena nitens. Bill.................	1	" "	" ..	" ....
192	"	"	Slab with Poteritcrinites caduceus. H. Orthis testudinaria. Dal. Rhynchonella capax. Con. Chaetetes Lycoperdon. H. Leptæna sericea. Sow....................	1	" "	" ..	" (The Potteriocrinus-Dendocrinus C. according to Miller.
194	"	"	Part of buckler of Asaphus gigas...............	1	" "	" ..	N. H. Winchell................
197	"	"	Orthoceras laqueatum. H. ?..................	1	Spring Valley...	" ..	" (Com. 214.)......
208	"	"	Strophomena tenuistriata. (?)...........	1	Sec. 17, Roch't'r, Olm Co.	Galena....	M. W. Harrington, (Garirick's quarry,) Compare 311, 204.)
214	"	P. W. Thayer, Geol. Survey....	Orthis testudinaria. Dal. Murchisonia bicincta. H. Orthoceras laqueatum. H. Leptæna sericea. Sow. Bellerophon bilobatus. Sow. Strophomena nitens. Bill. Rhynchonella capax. Con.................	1	Spring Valley, Fill. Co.	Trenton...	N. H. Winchell................
228	Oct. 1875	Geol. Sur..........	Leptæna serica. Sow............................	1	Fillmore Co............	" ..	" ....

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained — When.	Obtained — Whence.	NAME	No. of Specimens	Locality.	Formation	Collector and Remarks
242	Oct. 187[illegible]	Geo. Sur.	Cyrtoceras arcuatum. Hall	2	Holden, Goodhue Co.	Trenton	
243	"	" "	Oncoceras constrictum. Hall	1	" "	"	
244	"	" "	Asaphus gigas. H. (Left maxillary portion, or cheek.)	1	" "	"	
245	"	" "	Fragments of Asaphus gigas. Hall	3	" "	"	
252	July, 1875	" "	Orthoceras vertebrale. Hall	1	" "	"	
254	Oct. 1875	" "	Receptaculites	1	Lime City, Fillmore Co.	"	
258	"	" "	Cyrtoceras ? sp. ?	3	" "	"	
264	Sept. 1875	" "	Slabs with Strophemena and Orthis	2	Olmsted Co.	"	
269	"	" "	Orthis subquadrata. Hall	1	Sec. 30, Forestville Fill-	"	
279	Oct. 1875	" "	Orthis. n. sp.	1	Minneapolis. [more Co.	"	346.
293	Sept. 1875	" "	Strophomena fluctuosa. Bill	1	Mantorville, Dodge Co.	Galena	lay-
294	"	" "	Graptolithus scalaris. Linn	1	" "	"	lay-
295	"	" "	Graptolithus. ?	1	" "	"	lay-
296	"	" "	Discina Pelopea. Bill. (263.)	1	" "	"	lay-
297	Oct. 1875	" "	Chaetetes petropolitanus, Pander ?	1	Sec. 21, Forestville, Fill- [more Co.	Trenton.	
321	"	" "	Orthis. n. sp.	2	Minneapolis	"	
322	"	" "	Orthis perveta. Con.	1	"	"	rm..
323	"	" "	Rhynchonella capax. Con.	3	"	"	"
324	"	" "	" " "	5	"	"	"
325	"	" "	" " "	2	"	"	"
326	"	" "	" " "	1	"	"	"
327	"	" "	Orthis emacerata. H. var. multisecta. James.	1	"	"	

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
328	Oct. 1875.	Geol. Sur.	Rhynchonella capax. Con. (v. 220).	1	Minneapolis	Trenton	N. H. Winchell, Different form.
331	1873	" "	" " "	6	Minneap'lis, Finn's Glen	"	" Different form.
334	"	" "	Crinoid joints—(Schizocrinus nodusus H.)	4	" " "	"	"
335	"	" "	Crytolites compressus, Con.	1	" " "	"	"
336	"	" "	Orthis, n. sp.	1	" " "	"	"
339	1872	" "	Orthis, n. sp.	4 s'bs	Rochester, Olmsted Co.	"	N. H. Winchell—Whitcomb's Quarry, same as 346, 279, 648.
346	"	" "	Orthis, n. sp.	3	" " "	"	N. H. Winchell, same as 279, 648.
347	"	" "	Schizocrinus nodosus, H. (Stem)	1	Sec. 16, Pleasant Grove.	"	"
348	"	" "	Cyrtolites compressus. Con.	1	" " "	"	"
350	"	" "	Orthoceras strigatum. H.	1	" " "	"	"
351	"	" "	Slab containing chætetes Lycoperdon. H.	1	Pettit's Mill	"	"
352	"	" "	Oncoceras constrictum. H.	1	Pleasant Grove	"	"
356	"	" "	Strophomena. (sp. undistinguishable)	1	" "	"	" This shell is also found at Mantorville.
371	"	" "	" (tennistriata? v. No. 204 and 208.	1	Nr Rochester, Olmst'd Co	Galena	"
374	"	" "	Orthis.	12	St. Charles	Trenton	"
376	"	" "	Asaphus gigas. H.	1	"	"	"
879	"	" "	Orthoceras vertebrale. H.	1	"	"	"
381	"	" "	Orthoceras strigatum. H.	2	Pleasant Grove, Olm. Co.	"	"
392	Oct. 1872.	" "	Block with fragment of Orthis bella-rugosa. Con.	1	St. Charles	"	"
395	"	" "	Orthis.	1	Rochester, Olmsted Co.	"	" Same as 652.
399	1872	W. D. Hurlbut	Asaphus extans. H. (?) v. 90.	1	Trenton Falls, N. Y.	"	" Has a pustulated instead of a lamellose surface.
410	Oct. 1872.	Geol. Sur.	Asaphus gigas. H. and Strophomena filitexta. H	1	St. Charles	"	N. H. Winchell.
429	Oct. 1875.	" "	Orthis. n. sp.?	2	Spring Valley	Galena?	N. H. Winchell, (ventral valve is the most convex and hence cannot be Orth's occidentalis, v. Pal. Ohio vol. I. p. 96. The plications are also too coarse.

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
635	Nov. 1876	Centennial Exb	Volcanic Scoria	m'y	Kilauea, Sandwich Isl.		
636	"	" "	" " Pele's Hair	1	" " "		
637	Aug. 1873	Geol. Sur	Kaoline (green and impure)	1	Birch Coolie, Minn		Cut in rectangular block
638	"	"	" " "	1	" " "		Natural specimen
639	Nov. 1876	Centennial Exb	Lava tears	2	Kilauea, Sandwich Ils.		
640	Oct. 1872	Geol. Survey	Limonite (after Pyrite)	1	Sugar Loaf, Winona	Low. Mag.	Surface specimen
641	Nov. 1876	Centennial Exb	Water Crystals. (Quartz.)	4	Little Falls, N. Y.		
642	Oct. 1875	Geol. Sur	Orthis. n. sp?	2	Spring Valley	Galena	N. H. Winchell
643	"	"	Orthis	2	Minneapolis	Trenton	"
644	Aug. 1875	"	Orthis	4	Fountain, Fillmore Co.	"	" (Taylor's Quarry.)
645	"	"	Lingula quadrata. Eich	1	" " "	"	" " "
646	"	"	Chætetes Lycoperdon. H	9	" " "	"	" " "
647	"	"	Strophomena filitexta. H. Pal. vol. I, p. 82 (one ventral valve	1	" " "	"	" " "
648	"	"	Orthis. n. sp?	1	" " "	"	N. H. Winchell, same as 279, 346.
649	Sept. 1875	"		Indf	Olmsted Co	"	M. W. Harrington
650	?	"	Rhynchonella capax. Con	1	?		?
651	Aug. 1875	"	Orthis. n. sp	1	Fountain, Fillmore Co.	Trenton	N. H. Winchell
652	1872	"	Slabs with Asaphus gigas H. Orthis testudinaria, Dal. and a small Rhynchonellas, also a Gasteropod.	bks 6	Rochester, Olmsted Co.	"	"
653	July 1877	"	Cyrtolites compressus. Con	6	Minneapolis	"	C. L. Herrick
654	1873	"	Ceraurus vigilans H	1	Finn's Glen	"	N. H. Winchell
655	Oct. 1872	"	Leptaena sericea. Sow	1	Petit's Mill	"	"
656	"	"	Schizocrinus nodosus. H	1	"	"	"
657	"	"	Slab with Rhynchonella capax, Con. and Strophomena alternata, H. and Bellerophon bilobatus, H.	1	"	"	"
658	"	"	Calcareous tufa	1	Minneapolis		C. L. Herrick

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
659	1872	Geol. Sur	Atrypa recurvirostra. H. Blocks	6	Rochester, Minn	Trenton	N. H. Winchell
660	"	"	Atrypa recurvirostra. H	Indf	" "	"	" (taken from 659.)
661	Oct. 1872	"	Endoceras proteiforme, var. lineolatum. H	1	Pleasant Grove, (sec. 16)	"	"
662	"	"	Orthoceras junceum. H	1	" "	"	"
663	"	"	Cytoceras annulatum. H. and Orthoceras strig. H	1	" "	"	"
664	Aug. 1877	"	Petraia corniculum. H	Indf	Minneapolis	"	C. L. Herrick
665	"	"		2	"	"	"
666	"	"		Indf	"	"	"
667	"	"		1	"	"	"
668	"	"		1	"	"	"
669	"	"		14	"	"	"
670	"	"		7	"	"	"
671	"	"		2	"	"	"
672	"	"		1	"	"	"
673	"	"		1	"	"	"
674	"	"		9	"	"	"
675	"	"		4	"	"	"
676	"	"		1	"	"	"
677	"	"		2	"	"	"
678	"	"		2	"	"	"
679	"	"		2	"	"	"
680	"	"		1	"	"	"
681	"	"		1	"	"	"
682	"	"		1	"	"	"
683	"	"		12	"	"	"
684	"	"		1	"	"	"
685	"	"		1	"	"	"

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
686	Aug. 1877	Geol. Sur.		1	Minneapolis	Trenton	C. L. Herrick
687	"	"		3	"	"	"
688	"	"		1	"	"	"
689	"	"		1	"	"	"
690	"	"		1	"	"	"
691	"	"		1	"	"	"
692	"	"		4	"	"	"
693	"	"		1	"	"	"
695	"	"		1	"	"	"
696	"	"		2	"	"	"
697	"	"		2	"	"	"
698	"	"		1	"	"	"
699	"	"		4	"	"	"
700	"	"		1	"	"	"
701	"	"		5	"	"	"
702	"	"		2	"	"	"
703	"	"		2	"	"	"
704	"	"		1	"	"	"
705	"	"		7	"	"	"
706	"	"		1	"	"	"
707	"	"		2	"	"	"
708	"	"		3	"	"	"
708	"	"		1	"	"	"
709	"	"		1	"	"	"
710	"	"		1	"	"	"
711	"	"					"
712	"	"					" (Green slate.)

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
713	Aug. 1877	Geol. Sur.		2	Minneapolis	Trenton	C. L. Herrick (Green shale)
714	"	"		1	"	"	" " "
715	"	"		1	"	"	"
716	"	"		6	"	"	" (Green shale)
717	"	"		1	"	"	" " "
718	"	"		1	"	"	"
719	"	"		1	"	"	"
720	"	"		2	"	"	"
721	"	"		2	"	"	"
[illegible]	"	"		1	"	"	"
[illegible]	"	"		1	"	"	"
[illegible]	"	"		1	"	"	"
[illegible]	"	"		1	"	"	"
	"	"		1	"	"	"
	"	"		1	"	"	"
	"	"		1	"	"	"
	"	"		1	"	"	"
	"	"		1	"	"	"
	"	"		1	"	"	"
	"	"		1	"	"	" (Green shale.)
	"	"		2	"	"	" " "
	"	"		Indf	"	"	" " "
	"	"		2	"	"	" " "
	"	"		2	"	"	" " "
	"	"		Indf	"	"	" " "
	"	"		"	"	"	Fragment of above "
	"	"		1	"	"	" " "

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
740	Aug. 1877	Geol. Sur		2	Minneapolis	Trenton	C. L. Herrick
741	"	"		1	"	"	" (Green shale.)
742	"	"		3	"	"	" " "
743	"	"		1	"	"	"
744	"	"		3	"	"	"
745	"	"		1	"	"	"
746	"	"		1	"	"	"
747	"	"		1	"	"	"
748	"	"		2	"	"	"
749	"	"		1	"	"	"
750	"	"		1	"	"	"
751	"	"		1	"	"	"
752	"	"		1	"	"	"
753	"	"		5	"	"	"
754	"	"		Indf	"	"	" (Green shale.)
755	"	"		"	"	"	"
756	"	"		1	"	"	"
757	Fall, 1876	"		1	"	"	N. H. Winchell
758	"	"		1	"	"	"
759	"	"		1	"	"	"
760	"	"		1	"	"	"
761	"	"		1	"	"	"
762	"	"		1	"	"	"
763	"	"		1	"	"	"
764	"	"		1	"	"	"
765	"	"		1	"	"	"
766	Aug. 1877	"		Indf	"	"	C. L. Herrick

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
767	Aug. 1877	Geol. Sur.		5	Minneapolis	Trenton	C. L. Herrick
768	"	"		2	"	"	"
769	"	"		2	"	"	"
770	"	"		1	"	"	"
771	"	"		1	"	"	"
772	"	"		1	"	"	"
773	"	"		Indf	"	"	"
774	"	"		4	"	"	"
775	"	"		1	"	"	"
776	"	"		1	"	"	"
777	"	"		1	"		"
778	"	"		1	"		"
779	"	"		1	"		"
780	"	"		1	"		"
781	"	"		1	"		"
782	"	"		1	"		"
783	"	"		1	"		"
784	"	"		1	"		"
785	"	"		1	"		"
786	"	"		2	"		"
787	"	"		3	"		" (Green shale.)
788	"	"		1	"		"
789	"	"		1	"		" (Green shale.)
790	"	"		2	"		" " "
791	"	"		1	"		" " "
792	"	"		3	"		" " "
793	"	"		1	"		" " "

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
794	Aug. 1877	Geol. Sur		2	Minneapolis		C. L. Herrick, (Green shale.)
795	"	"		1	"		"
796	"	"		1	"		" (Green shale.)
797	"	"		Indf	"		" " "
798	Jan. 1876	Minn. Disk Co	Serpentine. (Precious)	3	Newburyport, Mass		
799	Nov. 1876	Cent. Exp	Graphite	2	Rockingham, Ont		Geol.Sur.of Can.(A.R. C.Selwyn)
800	"	"	Chalcopyrite	1	Almador Co., Cal		N. H. Winchell
801	?	A. D. Roe	Dipyre		Canaan, Conn		
802	Sept. 1873	Geol. Sur	Gypsum, (Selenite—Crystals)	Indf	Big Stone Lake, Minn	Cretaceo's	N. H. Winchell
803	Sept. 1875	"	Ankerite	1	Lanesboro, Minn	St.Lawrc'e	
804	Dec. 1877	A. K. Ridenour	Modiolopsis pholadiformis. F. & W	1	Oxford, Ohio	Low Sil	
805	"	"	Rhynchonella perlamellosa. Whit	2	Clarksville, Ohio	"	
806	"	"	Ambonychia radiata. Hall	1	Cincinnati, Ohio	"	
807	"	"	Avicula corrugata. James	1	"	"	
808	"	"	Orthis testudinaria. Dal	13	"	"	
809	"	"	Orthis retrorsa. Sal	1	Oxford, O	"	
810	"	"	Orthis dentata. Pander	2	Cincinnati, O	"	
811	"	"	Strophomena loxorhytis. Meek	2	"	"	
812	"	"	Lingula Covingtonensis. Hall. and Whit	1	"	"	
813	"	"	Orthis subquadrata. Hall	2	Clarksville, O	"	
814	"	"	Crania scabiosa. Hall	3	Cincinnati, O	"	
815	"	"	Orthodesma contracta. Hall	1	"	"	
816	"	"	Orthis fissicosta. Hall	2	"	"	
817	"	"	Modiolopsis modiolaris. Con	2	"	"	
818	"	"	Orthis lynx. Eich	1	"	"	
819	"	"	Anodontopsis Milleri. Meek	2	Versailles, Ind	"	
820	"	"	Orthis occidentalis. Hall	1	Cincinnati, O	"	

Catalogue of Specimens Registered in the General Museum in 1877—Continued. 12

Serial No.	Obtained — When	Obtained — Whence	NAME	No. of Specimens	Locality	Formation	Collector and Remarks
848	Dec. 1877	A. K. [illegible]	Orthis [illegible], Hall				
849	"	"	Nucleospira fusiformis, Hall				
850	"	"	Orthis [illegible], Hall				
851	"	"	Telamonya [illegible]				
852	"	"	Cleidophorus fabula				
[illegible]	"	"	Avicula insueta, Con				
901	Nov. 1876	Geo. F. Kunz	Bog Iron ore				
902	"	"	Freshwater limestone				
903	"	"	Loess				
904	"	"	Limestone				
905	"	"	Tertiary sandstone				
906	"	"	Molasse				
907	"	"	Calcareous Conglomerate				
908	"	"	S[illegible]stone				
909	"	"	Plastic Clay				
910	"	"	Porcelain Jasper				
911	"	"	Brown Coal				
912	"	"	Lignite				
913	"	"	Freshwater Limestone				
914	"	"	Tegelkalk				
915	"	"	Tegelkalk				
916	"	"	Tripoli Slate				
917	"	"	Tile or Brick Earth				
918	"	"	Calcaire Grossier				
919	"	"	Klebschiefer				
920	"	"	Gypsum				
921	"	"	Flysch				

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
922	Nov. 1876	Geo. F. Kuntz	Nummulitic Limestone .... No.	1			
923	"	"	Foraminifera Limestone .... No.				
924	"	"	Upper Chalk .... No.				
925	"	"	Chalk .... No.				
926	"	"	Limestone .... No.				
927	"	"	Glauconitic Chalk .... No.				
928	"	"	"Planer" Limestone .... No				
929	"	"	"Quader" Sandstone .... No				
930	"	"	Gault .... No				
931	"	"	Waelderthon .... No.				
932	"	"	Waelderthon .... No.				
933	"	"	Hastings Sandstone .... No.				
934	"	"	Lithographic Slate .... No.				
935	"	"	Coralline Limestone .... No	1			
936	"	"	Jura Limestone .... No	1			
937	"	"	Oxford Clay .... No	1			
938	"	"	Ornatenthon .... No.	1			
939	"	"	Cornbrash .... No	1			
940	"	"	Oolitic Limestone .... No.	1			
941	"	"	Clay Ironstone .... No.	1			
942	"	"	Lias Slate .... No.	1		Lias	
943	"	"	Lias Marl .... No.	1		"	
944	"	"	Lias Limestone .... No	1		"	
945	"	"	Lias Sandstone .... No.	1		"	
946	"	"	Slate .... No.	1			
947	"	"	Limestone .... No.	1			
948	"	"	Upper Keuper Sandstone .... No.	1			

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.		No. of Specimens.	Locality.	Formation	Collector and Remarks.
949	Nov. 1876	Geo. F. Kunz	Middle Keuper Sandstone	No. 49	1	Heilbronn, Wurt		
950	"	"	Keuper Marl	No. 50	1	Malsch, Baden		
951	"	Geol. Sur	Sandstone	No. 51	1	Sinsheim, Baden		
952	"	"	Slate	No. 52	1	Sinsheim, Baden		
953	"	"	"Muschelkalk"	No. 53	1	Wiesloch, Baden		
954	"	"	Lower "Muschelkalk"	No. 54	1	Mostroh		
955	"	"	"Bunter" Sandstone	No. 55	1	Heidelberg		
956	"	"	Sandstone	No. 56	1	Kaiserslautern		
957	"	"	Permian Gypsum	No. 57	1	Ihlfeld, Harz	Permian	
958	"	"	"Nechstein"	No. 58	1	Ilmenau, Thuringia		
959	"	"	Permian Dolomite	No. 59	1	Eisleben, Thuringia	Permian	
960	"	"	Copper Slate	No. 60	1	Rieschelsdorf, Hessia		
961	"	"	Permian ("Todtliegendes")	No. 61	1	Baden	Permian	
962	"	"	Coal Slate	No. 62	1	Saarbrucken	Carb	
963	"	"	Cannel Coal	No. 63	1	Wigan, Lancashire	"	
964	"	"	Carboniferous Sandstone	No. 64	1	Zwickau, Saxony	"	
965	"	"	Carboniferous Sandstone	No. 65	1	Le Fay, France	"	
966	"	"	Carboniferous Limestone	No. 66	1	Tournay, France	"	
967	"	"	Devonian Limestone	No. 67	1	Oberscheld, Nassau	Devonian	
968	"	"	Devonian Limestone	No. 68	1	Hof, Bavaria	"	
969	"	"	Gray Wacke	No. 69	1	Ober Lahnstein		
970	"	"	Clay Slate	No. 70	1	Kaub on the Rhine		
971	"	"	Silurian Limestone	No. 71	1	Prague, Bohemia	Silurian	
972	"	"	Silurian Limestone	No. 72	1	Prague, Bohemia	"	
973	"	"	Slate	No. 73	1	Hof, Bavaria		
974	"	"	Gneiss	No. 74	1	Freiberg, Saxony		
975	"	"	Mica Slate	No. 75	1	Gadernheim, Hessia		

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
976	Nov. 1876	Geo. F. Kunz	Talcose Slate No. 76	7	Kolmbach		
977	"	"	Granular Limestone No. 77	1	Auerbach		
978	"	"	Granite No. 78	1	Schlierbach		
979	"	"	Graphic Granite No. 79	1	Zwiesel, Bavaria		
980	"	"	Syenite No. 80	1	Reichenbach		
981	"	"	Hornblende Rock No. 81	1	Schriesheim, Baden		
982	"	"	Eclogite No. 82	1	Silberbach		
983	"	"	Diorite No. 83	1	Dillenberg, Nassau		
984	"	"	Aphanite No. 84	1	Sechshelder, Nassau		
985	"	"	Spilite No. 85	1	Limburg		
986	"	"	Serpentine No. 86	1	Kupferberg, Bavaria		
987	"	"	Gabbro No. 87	1	Wurlitz		
988	"	"	Porphyry No. 88	1	Ziegelhausen, Baden		
989	"	"	Melaphyre No. 89	1	Ilmenau, Thuringia		
990	"	"	Basalt No. 90	1	Auerbach, Hessia		
991	"	"	Doleryte No. 91	1	Katzenbuckel		
992	"	"	Amygdaloidal Doleryte No. 92	1	Sasbach, Baden		
993	"	"	Phonolyte No. 93	1	Rhaengebirge		
994	"	"	Trachyte No. 94	1	Stenzelberg, Siebeng'b'g		
995	"	"	Sanidine Trachyte No. 95	1	Drachenfels		
996	"	"	Trachyte Conglomerate No. 96	1	Ober Dollendorf, Rhine		
997	"	"	Trass No. 97	1	Brohl		
998	"	"	Pitchstone No. 98	1	Meissen, Saxony		
999	"	"	Obsidian No. 99	1	Lipari Isles		
1000	"	"	Lava No. 100	1	Mt. Vesuvius, Italy		
1001	"	"	Calamine	178	Ogdensburg, N. Y		
1002	"	"	Calamine and Smithsonite	3	"		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1003	Nov. 1876	Geo. F. Kunz	Calamine	1	Franklin, N. J		
1004	"	"	Natrolite	96	Bergen Hill, N. J		
1005	"	"	Datolite	138	"		
1006	"	"	Calcite resembling Datolite	1	"		
1007	"	"	Calcite (modified)	5	"		
1008	"	"	Calcite	78	"		
1009	"	"	Calcite	11	Franklin, N. J		
1010	"	"	Mesolite	10	Bergen Hill, N. J		
1011	"	"	Datolite and compact Mesolite	2	"		
1012	"	"	Compact Mesolite	1	"		
1013	"	"	Mesolite and Datolite	1	"		
1014	"	"	Peculiar form of Calcite	1	"		
1015	"	"	Tabular Calcite	5	"		
1016	"	"	Natrolite, Analcite and Prehnite	1	"		
1017	"	"	Thomsonite	1	"		
1018	"	"	Smithsonite	7	Franklin, N. J		
1019	"	"	Quartz	30	Hot Springs, Ark		
1020	"	"	Sussexite	1	Franklin, N. J		
1021	"	"	Seyberlite	1	Amity, N. Y		
1022	"	"	Datolite and Pyrite	2	Bergen Hill, N. J		
1023	"	"	Willemite (Troostite)	109	Franklin, N. J		
1024	"	"	Zincite (Ruby)	31	"		
1025	"	"	Amphibole (Hornblende)	135	"		
1026	"	"	Brown Tourmaline	1	"		
1027	"	"	Yellow Stilbite	1	Bergen Hill, N. J		
1028	"	"	Sphalerite (Compact Blende)	4	Bethlehem, Pa		Peculiar to locality
1929	"	"	Sphalerite (Blende)	36	Franklin, N. J		

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1030	Nov. 1876	Geo. F. Kunz	Biotite (Black Iron Mica)	1	Franklin, N. J		
1031	"	"	Spartaite	5	"		
1032	"	"	Egyptian Marble	1	Italy		
1033	"	"	Chalcopyrite	1	Queensland		
1034	"	"	Cassiterite	1	New South Wales		
1035	"	"	Hydraulic Cement (Rock)	1	R ndout, N. Y		
1036	"	"	Franklinite	9	Franklin, N. J		
1037	"	"	Sphalerite (Compact Blende)	2	Bethlehem, Pa		Peculiar variety, only found here
1038	"	"	Compact Thomsonite	1	Bergen Hill, N.J		
1039	"	"	Willemite and Thomsonite	1	Franklin, N. J		
1040	"	"	Pectolite	175	Bergin Hill, N. J		
1041	"	"	Mountain Paper	1	West Chester Co., N. Y		
1042	"	"	Brown Garnet	119	Franklin, N. J		
1043	"	"	Brown Garnet	1	"		The rest Wellemite (Troostite) and perhaps Pyroxene (Jeff.)
1044	"	"	Zincite	53	"		
1045	"	"	Quartz (Chert) in Schoharie grit	1	Schoharie, N. Y		
1046	"	"	Phlogopite	27	Franklin, N. J		Transparent through the sides
1047	"	"	Franklinite	273	"		
1048	"	"	Willemite	157	"		
1049	"	"	Franklinite and Zincite	180	"		
1050	"	"	Zincite (with Calcite)	49	"		
1051	"	"	Pyroxene	88	"		
1052	"	"	Chalcopyrite	4	"		
1053	"	"	Gahnite (Dysluite)	50	"		
1054	"	"	Graphite	100	New York		
1055	"	"	Tourmaline (Green)	34	Franklin, N. J		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1056	Nov. 1876	Geo. F. Kunz	Talc	12	Franklin, N. J		
1057	"	"	Surpentine (Precious Serpentine)	3	Montville, N. J		
1058	"	"	Calcite	3	Franklin, N. J		
1059	"	"	Apatite	18	"		
1060	"	"	Zincite and Willemite	3	"		
1061	"	"	Lepidomelane	9	"		
1062	"	"	Willemite, Franklinite and Zincite	8	"		
1063	"	"	Sussexite, Zincite and Franklinite	1	"		
1064	"	"	Franklinite, Zincite, Rhodochrosite (Dialogite) and Tephroite	1	"		
1065	"	"	Red and Green Corundum, Chondrodite	2	"		
1066	"	"	Garnet (Essonite)	1	"		
1067	"	"	Pyroxene and Amphibole (Pargasite)	2	"		
1068	"	"	Gahnite (Dysluite) and Garnet	3	"		
1069	"	"	Spinel	9	"		
1070	"	"	Chondrodite	8	"		
1071	"	"	Chondrodite and Fluorite	2	"		
1072	"	"	Epidote	5	"		
1073	"	"	Willemite (Troostite) and Franklinite	1	"		
1074	"	"	Pyroxene (Jeffersonite) and Apatite	1	"		
1075	"	"	Amphibole (Hornblende) and Titanite (Sphene)	30	"		
1076	"	"	Yellow Calcite	4	"		
1077	"	"	Black Garnet	35	"		
1078	"	"	Pyroxene (Jeffersonite)	44	"		
1079	"	"	Calcite (Stalactite)	1	Durham Cave, 10 mi. below Easton, Pa.		
1080	"	"	Native Copper	9	Lake Superior		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1081	Nov. 1876	Geo. F. Knnz	Garnet (Colophonite) and Franklinite	2	Franklin, N. J		
1082	"	"	Garnet, (Colophonite) Franklinite & Willemite	1	"		
1083	"	"	Garnet, (Colophonite)	7	"		
1084	"	"	Pyroxene (Jeffersonite) and Garnet	3	"		
1085	"	"	Garnet, var. Melanite	75	"		
1086	"	"	Corundum (Sapphire)	1	"		
1087	"	"	Azurite	2	Chili		
1088	"	"	Iridescent Datolite	2	Bergen Hill, N. J		Very rare
1089	"	"	Prehnite	39	"		
1090	"	"	Feldspar	52	Turin, N. Y		
1091	"	"	Ruby Corundum	2	Franklin, N. J		
1092	"	"	Gold	2	North Carolina		
1093	"	"	Gold Quartz	3	California		
1094	"	"	Calcite	1	England		
1095	"	"	Pyromorphite (Brown Lead Ore)	1	Ems, Germany		
1096	"	"	Millerite	2	Gap Mimes, Pa		
1097	"	"	Pyrite	1	Roxbury, Ct		
1098	"	"	Surpentine (Chrysotile)	1	Montville, N. J		
1099	"	"	Talcose Slate	1	Staten Island		
1100	"	"	Rensselærite	3	St. Lawrence Co., N. Y		
1101	"	"	Amphibole (Asbestus)	2	Baltimore, Md		
1102	"	"	Amphibole (Hornblende)	1	Amity, N. Y		
1103	"	"	Apophyllite and Laumontite	2	Bergen Hill, N. J		
1104	"	"	Fontainebleau Sandstone	1	Europe		Concretions
1105	"	"	Millerite, Hematite (Specular Iron) & Siderite	1	Antwerp, N. J		
1106	"	"	Calamine in Sphalerite (Blende)	2	Granby, Mo		
1107	"	"	Fibrous Red Hematite	1	Maryland		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
1108	Nov. 1876	Geo. F. Kunz	Blue Corundum	1	Franklin, N. J		
1109	"	"	Staurolite	1	Georgia		
1110	"	"	Serpentine (Baltimorite)	1	Wood mine, Texas, Lancaster Co., Pa.		
1111	"	"	Anthophyllite	1	Wood mine, Texas, Lancaster Co., Pa.		
1112	"	"	Black Garnet	2	Franklin, N. J		
1113	"	"	Brown Garnet and Epidote	4			
1114	"	"	Aluminite (Hallite)	5	Texas, Pa		
1115	"	"	Grey Tephroite and Zincite	1	Franklin, N. J		
1116	"	"	Hematite (Specular Iron)	1	Island of Elba		
1117	"	"	Magnetite	2	Sussex Co., N. Y		
1118	"	"	Rutile (Rutilated Quartz)	1	Switzerland		
1119	"	"	Pinite (Agalmatolite)	1	China		
1120	"	"	Pent. Dodec Pyrite	11	New Jersey		
1121	"	"	Corundum	4	Franklin, N. J		
1122	"	"	Cuprite	1	Valparaizo, Chili		
1123	"	"	Prehnite and Natrolite	4	Bergen Hill, N. J		
1124	"	"	Silver and Gold in Pyrite, Galenite (Galena)	1	California		
1125	"	"	Pyrite	40	Franklin, N. J		
1126	"	"	"Greenish Mica"	2	Connecticut		
1127	"	"	Millerite	3	Antwerp, N. Y		
1128	"	"	Phlogopite	6	St. Lawrence Co., N. Y.		
1129	"	"	Vesuvianite (Idocrase)	5	Amity, N. Y		
1130	"	"	Brookite	1	Ellenville, N. Y		Trauslucent yellow on quartz
1131	"	"	Stilbite	2	Poorah, Hindostan		
1132	"	"	Datolite and Natrolite	11	Bergen Hill, N. J		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1133	Nov. 1876	Geo. F. Kunz	Datolite and Stilbite	2	Bergen Hill, N.J		
1134	"	"	Apophyllite	67	"		
1135	"	"	Calcite and Stilbite	5	"		
1136	"	"	Quartz and Limonite,	1	Hoboken, N. J,		
1137	"	"	Stilbite	6	New York City		
1138	"	"	Calcite and Pyrite	11	Bergen Hill, N. J		
1139	"	"	Epidote	12	Franklin, N. J		
1140	"	"	Quartzite Conglomerate.,	1	Morristown, N. Y.		
1141	"	"	Crystalline Furnace Slag	1	Easton, Pa		
1142	"	"	Smithsonite	4	Franklin, N. J		
1143	"	"	Limonite and Gœthite (Lepidokrokite)	2	Chestnut Hill, Pa		
1144	"	"	Chabazite	1	New York City		
1145	"	"	Quartz	1	Dauphiney, France		
1146	"	"	Zincite and Tephroite	9	Franklin, N. J		
1147	"	"	Franklinite and Tephroite	9	"		
1148	"	"	Franklinite, Zincite and Tephroite	16	"		
1149	"	"	Franklinite, Zincite and Rhodonite	1	"		
1150	"	"	Calcite and Analcite	7	Bergen Hill, N.J		
1151	"	"	Witherite	6	England		
1152	"	"	Magnesite, compact	7	Hoboken, N. J.		
1153	"	"	Dolomite (Pearl Spar)	4	Lockport, N. Y	Niagara	
1154	"	"	Dolomite(Pearl Sp'r)and Calcite (Dog Tooth Sp'r	1	"		
1155	"	"	Serpentine	2	Gouverneur, N, Y		
1156	"	"	Sussexite, Ruby Zincite and Rhodochrosite (Dia.	1	Franklin, N. J		
1157	"	"	Herschelite and Gismondite in Trachyte	1	Cyclopean Islands		
1158	"	"	Slickensides	3	Franklin, N. J		
1159	"	"	Pectolite and Prehnite	3	Bergen Hill, N.J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1160	Nov. 1876	Geo. F. Kunz	Stilbite	17	Bergen Hill, N.J		
1161	"	"	Sphalerite (Blende)	4	Missouri		
1162	"	"	Calcite (Dog Tooth Spar)	3	Lockport, N. Y		
1163	"	"	Spinel and Chondrodite	3	Franklin, N. J		
1164	"	"	Ophiolyte	1	New York City		
1165	"	"	Datolite and Calcite	3	Bergen Hill, N.J		
1166	"	"	Prehnite and Sphalerite (Blende)	1	"		
1167	"	"	Prehnite, Gmelinite and Blende	5	"		
1168	"	"	Ægirite	14	Near Magnet Cove, Ark		
1169	"	"	Chrysocolla	1	Maryland		
1170	"	"	Chrysocolla and Atacamite	1	"		
1171	"	"	Wulfenite and Pyromorphite	3	Southampton, Mass		
1172	"	"	Limonite	10	Staten Island		
1173	"	"	Quartz (Silicified Wood)	1	Colorado		
1174	"	"	Feldspar and Ægirite	1	Near Magnet Cove, Ark		
1175	"	"	Trap Crystals	2	Bergen Hill, N.J		
1176	"	"	Chalcopyrite	8	Tennessee		1
1177	"	"	Quartz (Moss-agate)	5	Cheyenne, W. T		
1178	"	"	Copalite (Copal)	4	Zanzibar, Africa		
1179	"	"	Quartz (Smoky)	5	Colorado (Pikes Peak)		
1180	"	"	Quartz (Chalcedony)	2	Germany		
1181	"	"	Quartz (Agate)	2	"		With fine design
1182	"	"	Quartz (Jasper)	1	"		
1183	"	"	Quartz (Agate)	1			
1184	"	"	Quartz (Onyx)	1	Oberstein, Germany		
1185	"	"	Quartz (Agate)	1	Oberstein, Germany		
1186	"	"	Smoky Quartz	10	Magnet Cove, Ark		

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1187	Nov. 1876	Geo. F. Kunz	Manganite	7	Nova Scotia		
1188	"	"	Sphalerite (Blende) and Pyrite	1	Pike's Peak, Col		Blende resembles Galena
1189	"	"	Magnetite	4	Nova Scotia		
1190	"	"	Beryl	1	Connecticut		
1191	"	"	Feldspar	1	New York City		
1192	"	"	Serpentine with Chromite	1	Hoboken, N. J		
1193	"	"	Magnetite	2	Port Henry		
1194	"	"	Siderite and Gneiss	1	New York City		
1195	"	"	Æginite on Orthoclase (Feldspar)	1	Near Magnet Cave, Ark.		
1196	"	"	Talc	1	Staten Island		
1197	"	"	Orthoclase	7	New York City		
1198	"	"	Apophyllite and Analcite	3	Bergen Hill, N. J		
1199	"	"	Apophyllite and Prehnite	2	"		
1200	"	"	Magnesite in Cerolite	6	Hoboken, N. J		
1201	"	"	Magnesite	1	" "		
1202	"	"	Datolite. White	2	Bergen Hill, N. J		
1203	"	"	Analcite	12	"		
1204	"	"	Datolite and Natrolite	2	"		
1205	"	"	Natrolite and Analcite	2	"		Large cryst. for loc
1206	"	"	Apophylite and Gmelinite	1	"		
1207	"	"	Datolite and Gmelinite	3	"		
1208	"	"	Natrolite and Apophyllite	2	"		
1209	"	"	Orthoclase (Adularia)	1	Windsor, Mass		
1210	"	"	Brown Harmotome	1	Hudson, N. Y		
1211	"	"	Shell Limestone	1	"		
1212	"	"	Graphite (Picture Mica)	1	Lancaster Co., Pa		
1213	"	"	Pyrrhotite	4	St. Anthony's Nose, N. Y.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimen.	Locality.	Formation	Collector and Remarks.
1214	Nov. 1876	Geo. F. Kunz	Chalcopyrite	7	Vermont		
1215	"	"	Chalcopyrite	2	Cuba		
1216	"	"	Pectolite	4	Bergen Hill, N. J		Odd form
1217	"	"	Calcite	1	Unknown		
1218	"	"	Slag	4	From Furnace near Easton, Pa.		
1219	"	"	"From Iron Furnace"	1	Northern New York		
1220	"	"	Mica	4	Franklin, N. J		
1221	"	"	Natrolite and Stilbite	2	Bergen Hill, N. J		
1222	"	"	Thomsonite	5	"		
1223	"	"	Quartz	1	Hoboken, N. J		
1224	"	"	Garnet (Melanite)	1	Franklin, N. J		
1225	"	"	Opal	2	Honduras		
1226	"	"	Rhodonite (Crystals of Fowlerite)	1	Franklin, N. J		
1227	"	"	Pyrolusite	1	Germany		
1228	"	"	Pumice	2	"		
1229	"	"	Pyrite	6	Kentucky		
1230	"	"	Datolite and Analcite	2	Bergen Hill, N. J		
1231	"	"	Datolite, Natrolite and Prehnite	1	"		
1232	"	"	Barite	13	Cheshire, Ct		
1233	"	"	Calamine	1	Franklin, N. J		
1234	"	"	Aurichalcite (Green Calamine)	2	Ogdensburg, N. Y		
1235	"	"	Willemite (Troostite) and Franklinite	2	Franklin, N. J		
1236	"	"	Serpentine	6	Hoboken, N. J		
1237	"	"	Hematite (Specular Iron) after Franklinite	1	Franklin, N. J		
1238	"	"	Brucite	2	Hoboken, N. J		
1239	"	"	Hydromagnesite	5	"		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
1240	Nov. 1876	Geo. F. Kunz	Ægirite with Nephelite, (Elæolite)	6	Magnet Cave, Ark		
1241	"	"	Rutile (Nigrine)	38	"		
1242	"	"	Phosphatic Nodule	5	Charleston, S. C		
1243	"	"	Wulfenite and Pyromorphite	5	Southampton, Mass		
1244	"	"	acolumite)	7	North Carolina		
1245	"	"		3	Westchester Co., N. Y.		
1246	"	"		1	Texas, Pa.		
1247	"	"	te	1	Delaware Co., Pa.		Detached
1248	"	"		4	New Alstead, N. H		
1249	"	"	and Tephroite	1	Franklin, N. J.		
1250	"	"	and Pyromorphite	1	Phœnixville, Pa		
1251	"	"	e and Willemite	10	"		
1252	"	"	te on Sphalerite (Blende).	2			
1253	"	"		1			
1254	"	"		30			
1255	"	"	olusite	2			
1256	"	"		2			
1257	"	"		1			
1258	"	"		1			
1259	"	"		1			
1260	"	"		2			
1261	"	"	al (Lignite)	5	England		
1262	"	"	us Hematite	1	Clinton, N. Y		
1263	"	"		1	Unkown		
1264	"	"	Gypsum	1	Nova Scotia		
1265	"	"		2	Scales Mound, Ill.		
1266	"	"	(Kammererite)	3	Lancaster Co., Pa.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1267	Nov. 1876	Geo. F. Kunz		7	ark......		
1268	"	"		4			
1269	"	"		1			
1270	"	"		8			
1271	"	"		1			
1272	"	"		2			
1273	"	"		1			
1274	"	"		4			
1275	"	"		1			
1276	"	"		1			
1277	"	"		4			
1278	"	"	luorite (Fluor).	1			
1279	"	"	patite..........	1			
1280	"	"		1			
1281	"	"		1	.Scotia.		
1282	"	"	ekite....	1			
1283	"	"		1			
1284	"	"	(Bitumen) on	1			
1285	"	"		4			
1286	"	"		3			
1287	"	"		1			
1288	"	"		1			
1289	"	"		2			Peculiar Crystals...
1290	"	"		1			
1291	"	"		6	Mass...		
1292	"	"					

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1293	Nov. 1876	Geo. F. Kunz	Cyanite	1	Pennsylvania		
1294	"	"	Stilbite (Sphærostilbite)	2	Bergen Hill, N.J		Very rare
1295	"	"	Titanite (Sphene var Lederite)	1	Franklin. N. J		
1296	"	"	Wernerite (Scapolite)	16	Franklin, N. J		
1297	"	"	Tourmaline	1	Lambertville, Pa		
1298	"	"	Psilomelane	2	Hot Springs, Ark		
1299	"	"	"Pipe Ore"	2	Kentucky		
1300	"	"	Melaconite (Tenorite) and Calcite	1	Unknown		
1301	"	"	Zincite (Crystals of yellow Oxyde of Zinc)	1	Franklin, N. J		"From fused ore heaps."
1302	"	"	Psilomelane	2	Virginia		
1303	"	"	Molybdenite	1	Haddam, Conn		
1304	"	"	Ripidolite (Clinochlore)	4	Lancaster Co., Pa		
1305	"	"	Atacamite	2	Atacama, Chili		
1306	"	"	Prehnite, Thomsonite and Laumontite	1	Bergen Hill, N.J		
1307	"	"	Dioryte	1	"		
1308	"	"	Mineral Coal (Lignite)	1	Alaska		
1309	"	"	Azurite	1	Chili, S. A		
1310	"	"	Spodumene	1	Franklin, N. J		
1311	"	"	Amphibole (Tremolite)	1	Lewis Co., N. Y		
1312	"	"	Chalcocite	2	Bristol, Conn		
1313	"	"	Hypersthene	3	Lewis Co., N. Y		
1314	"	"	Ferruginous Quartz	5	Brooklyn, N. Y	Drift	
1315	"	"	Siderite	1	Easton, Pa		
1316	"	"	Talc (Steatite Pseudo after Pyroxene)	4	Franklin, N. J		
1317	"	"	Cacoxenite	1	Antwerp, N. Y		
1318	"	"	Zaratite	4	Texas, Pa		
1319	"	"	Amphibole (Hornblende) and Graphite	1	Amity, N. Y		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1320	Nov. 1876	Geo. F. Kunz	Uraconite (Uranochre)	1	St. Just, Scotland		
1321	"	"	Anglesite	1	Phœnixville, Pa		
1322	"	"	Hypersthene and Pyrite	1	Franklin, N. J		
1323	"	"	Amphibole (Hornblende) and Apatite	1	"		
1324	"	"	"Silver Mica"	1	"		
1325	"	"	Schorlomite	9	Magnet Cove, Ark		
1326	"	"	Garnet	1	Franklin, N. J		
1327	"	"	Quartz	10	"		
1328	"	"	Tourmaline	8	"		
1329	"	"	Hypersthene	1	"		
1330	"	"	Seybertite	2	"		
1331	"	"	Talc (Steatite, Pseudo, after some mineral)	1	"		
1332	"	"	Slickensides on White Topaz	1	"		
1333	"	"	Talc (Steatite on Graphite)	1	"		
1334	"	"	Phlogopite	2	Sterling, N. Y		
1335	"	"	Tourmaline	2	New York City		
1336	"	"	Garnet (Melanite) containing Schorlomite	4	Magnet Cove, Ark		
1337	"	"	Rhodochrosite (Dialogite)	2	Franklin, N. J		
1338	"	"	Willemite (Green—rare color)	11	"		
1339	"	"	Dolomite (Perl Spar) in trans Gypsum (Silenite)	1	Lockport, N. Y		
1340	"	"	Zincite and Dialogite	1	Franklin, N. J		
1341	"	"	Niccoliferous Pyrites	15	"		
1342	"	"	Franklinite and Lepidomelane (Black Mica)	1	"		
1343	"	"	Chalcopyrite	1	California		
1344	"	"	Sphalerite (Blende)	117	Oronogo, Mo		
1345	"	"	Hematite	1	Antwerp, N. Y		
1346	"	"	Quartz (Chalcedony)	1	Mt. Tom, Mass		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1347	Nov. 1876	Geo. F. Kunz	Quartz (Flint), with fossils from chalk	1	England		
1348	"	"	"Lithomarge."	1	Bergen Hill, N. J		
1349	"	"	Prehnite and Thomsonite	1	"		
1350	"	"	Orthoclase	1	Dixon's Quarry, Del		
1351	"	"	Malachite in Red Hematite	1	Maryland		
1352	"	"	Stilbite	4	Franklin, N. J		
1353	"	"	Brown Tourmaline	2	"		
1354	"	"	Red Hematite	1	Staten Island		
1355	"	"	Mineral Coal (Cannel Coal)	2	England		
1356	"	"	Mineral Coal (Anthracite)	1	Scranton, Pa.		
1357	"	"	Quartz	9	Ellenville, N. Y.		
1358	"	"	Quartz	1	Switzerland		
1359	"	"	Fluorite	1	Muscalonge Lake, N. Y.		
1360	"	"	Garnet (Essonite)	1	New Hampshire		
1361	"	"	Pyroxene and Amphibole (Hornblende)	2	Franklin, N. J		
1362	"	"	Sphalerite (Blende) and Asphaltum (Bit'n)	1	Missouri		
1363	"	"	Amphibole (Hornblende) and Graphite	1	Franklin, N. J		
1364	"	"	Spinel	1	Hamburg, N. Y		
1365	"	"	Gypsum (Selenite)	1	Nova Scotia		
1366	"	"	Malachite	1			
1367	"	"	Chromite	1	California		
1368	"	"	Serpentine	1	Hoboken, N. J		
1369	"	"	Epidote	2	Lake Superior		
1370	"	"	Epidote and Orthoclase	3	"		
1371	"	"	Epidote and Quartz	1	"		
1372	"	"	Green and Red Corundum	1	Franklin, N. J		
1373	"	"	Sphalerite (Blende) and Galenite (Galena)	3	Oronogo, Mo		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1374	Nov. 1876	Geo. F. Kunz	Copper in Calcite with Epidote	2	Lake Superior		
1375	"	"	"Spiegeleisen"	1	Sweden		
1376	"	"	Magnetite	1	Franklin, N. J		
1377	"	"	Amygdaloid	1	Massachusetts		
1378	"	"	Galenite in Fluorite	2	Galena, Ill		
1379	"	"	Pyrargyrite (Ruby Blende)	3	Oronogo, Mo		
1380	"	"	Siderite (Carbonate of Iron)	1	North Carolina		
1381	"	"	Psilomelane	2	Northern New York		
1382	"	"	Chromite and Penninite	2	Texas, Pa		
1383	"	"	Calamine and Sphalerite (Blende)	1	Missouri		
1384	"	"	Calcite and Dolomite (Pearl Spar)	1	Lockport, N. Y		
1385	"	"	Quartz (Chalcedony) on Trihedral Quartz	1	Poorah, Hindostan		
1386	"	"	Galenite and Pyrargyrite (Ruby Blende)	2	Oronogo, Mo		
1387	"	"	White and Red Zincite	2	Franklin, N. J		
1388	"	"	Calamine	2	Granby, Mo		
1389	"	"	Epidote and Orthoclase (Feldspar)	9	Lake Superior		
1390	"	"	Galenite	6	Oronogo, Mo		
1391	"	"	Franklinite and Ruby Zincite	2	Franklin, N. J		
1392	"	"	Ferruginous Quartz	1	Connecticut		
1393	"	"	Pinite (Agalmatolite)	1	China		Chinese figure stone
1394	"	"	Apatite	4	Bob Lake, Canada		
1395	"	"	"Kidney Ore,"	1	Bethlehem, Pa		
1396	"	"	Red Hematite	1	Antwerp, N. Y		
1397	"	"	Limonite	3	Salisbury, Conn		
1398	"	"	Diaspore	2	Chester, Mass		
1399	"	"	Slag from Furnace	1	New York		
1400	"	"	Cuprite	1	England		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
	When.	Whence.					
1401	Nov. 1876	Geo. F. Kunz	Pyrite. Pent. Dodec	1	Belgium		
1402	"	"	Sulphur	1	Sabine, West Indies		
1403	"	"	Native Bismuth	1	Connecticut		
1404	"	"	Pyrophyllite	1	Deep River, N. C		
1405	"	"	Collyrite (Dillnite) with Diaspore	1	Shemnitz, Hungary		
1406	"	"	Feldspar	1	Desert of Sinai, Africa		
1407	"	"	Garnet	1	Piedmont, Italy		
1408	"	"	Garnet	2	New Town, Conn		
1409	"	"	Garnet	1	Canada		
1410	"	"	Garnet	1	St. Lawrence Co., N. Y		
1411	"	"	Quartz (Chalcedony)	1	Poonah, Hindostan		
1412	"	"	Beauxite	1	Cabasse, France		
1413	"	"	Feldspar	2	Lewis County, N. Y		
1414	"	"	"Red Ochre"	1	Staten Island		
1415	"	"	Beryl	2	Ackworth, N. H		
1416	"	"	Heulandite	1	New York City		
1417	"	"	Serpentine (Marmolite)	1	Hoboken, N. Y		
1418	"	"	Calamine	1	Saucon Valley, Pa		
1419	"	"	Quartz (Chalcedony)	1	Florida		
1420	"	"	Pyrite in Coal Shale	1	Scanton, Pa		
1421	"	"	Hauynite (in Lava)	1	Anderbach, Ger		
1422	"	"	Native Copper with Silver	1	Lake Superior		Showing Silver in spots
1423	"	"	Magnetite	2	Nova Scotia		
1424	"	"	Quartz (Petrified Wood)	1	California		
1425	"	"	White Apatite	1	Santander, Spain		
1426	"	"	Amphibole (Tremolite)	3	Gouverneur, N. Y		
1427	"	"	Glauberite and Mexite, (Hayesine)	2	Iquique, S. A		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1428	Nov. 1876	Geo. F. Kunz	Aragonite	1	Bastennes Landes, Fr		
1429	"	"	Quartz (Brown Jasper)	2	Murphreys, Cal		
1430	"	"	Orthoclase	1	Liperville, Pa		
1431	"	"	Quartz (Silicified Wood)	1	Nevada County, Cal		
1432	"	"	Cerolite	1	Hoboken, N. J		
1433	"	"	Molybnite	1	Westmoreland. Mass		
1434	"	"	Cyanite	2	Trumbull. Conn		
1435	"	"	Serpentine	1	St. Lawrence, N. Y		
1436	"	"	Serpentine (Precious Serpentine)	1	Gouverneur, N. Y		
1437	"	"	Hematite (Specular Iron)	3	Antwerp, N. Y		
1438	"	"	Sphalerite (Blende)	1	Ellenville, N. Y		
1439	"	"	Quartz containing Asphaltum (Bitumen)	4	Herkimer County, N. Y		
1440	"	"	"Hagemanite"	1	Ivigtut, Greenland		
1441	"	"	Cinnabar	1	West California		
1442	"	"	Cerussite	1	Germany		
1443	"	"	Cerussite	2	Davidson County, N. C		
1444	"	"	Chrysolite (Olivine) in Trap	1	Europe		Exact locality unknown
1445	"	"	Quartz (Calloused)	128	Crystal Mountains, Ark		
1446	"	"	Quartz	3	Unknown		
1447	"	"	Quartz from Lead Mine	1	Southampton, Mass		
1448	"	"	Calcite [modified]	1	Bergen Hill. N. J		
1449	"	"	Quartz (Geode)	1	Illinois		
1450	"	"	Tourmaline and Smoky Quartz	1	New York City		
1451	"	"	Brucite	1	Texas, Pa		
1452	"	"	Mica Crystals	1	Sterling, N. J		
1453	"	"	Calcite	1	Roseville, N. J		
1454	"	"	Flourite and Apatite	1	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1455	Nov. 1876	Geo. F. Kunz.	Amphibole (Byssotite)	1	Bergen Hill, N. J		
1456	"	"	Calcite (Calc Tufa)	1	Cansted, Germany		
1457	"	"	Porcelanite (Porcelain Jasperi	1	Germany		
1458	"	"	Gmelinite	1	Two Islands, N. Scotia		
1459	"	"	Quartz (Jasper) and Serpentine	1	Hoboken, N. J		Point of contact between—
1460	"	"	Graphite Picture Mica	5	Sussex Co., N. J		
1461	"	"	Quartz (Rose)	1	Franklin, N. J		
1462	"	"	Apophyllite	6	Bergen Hill, N. J		Crystals of a rare form
1463	"	"	Mica	2	New Hampshire		
1464	"	"	Titanite (Sphene)	4	Franklin, N. J		
1465	"	"	Titanite (Sphene)	1	Diana, N. Y		
1466	"	"	Mica	2	New York City		
1467	"	"	Quartz (Green Jasper)	1	Connecticut		
1468	"	"	Feldspar	1	France		[form
1469	"	"	Prehnite and Pectolite (crystallized)	1	Bergen Hill, N. J		In separate crystals—very rare
1470	"	"	Geode of Limonite	1	Staten Island, N. Y		
1471	"	"	Pyrites (radiated)	1	Germany		
1472	"	"	Iridescent Limonite	1	Chestnut Hill, Pa		
1473	"	"	Quartz (Amethyst)	2	Thunder Bay, L. S.		
1474	"	"	Quartz	1	Parana, Brazil		
1475	"	"	Quartz (in matrix)	1	Herkimer Co., N. Y		In calciferous sandrock
1476	"	"	Analcite	1	Cyclopean Is		Rare form—clear and showing
1477	"	"	Rhodonite (Fowlerite crystallized)	1	Franklin, N. J		[face of cube
1478	"	"	Rhodocrosite (Dialogite)	1	Franklin, N. J		Contains Magnesia
1479	"	"	Pyroxene (Pargasite)	2	Franklin, N. J		
1480	"	"	Calcite (Argentine)	4	Montville, N. J		
1481	"	"	Quartz (Bloodstone)	4	Texas		

Catalogue of Specimens Registered in the General Museum in 1877.--Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
1482	Nov. 1876	Geo. F. Kunz	Quartz (Rose)	2	Haddam, Ct.		
1483	"	"	Rutile	1	Franklin, N. J		
1484	"	"	Serpentine (Chrysotile)	3	Montville, N. J		
1485	"	"	Compact Garnet	1	New York City		
1486	"	"	Pyroxene	1	Lewis Co. N. Y		
1487	"	"	Cyanite (Rhætizite)	1	Germany		
1488	"	"	Pectolite	2	Bergen Hill, N. J		Rare forms
1489	"	"	Stilbite	1	Nova Scotia		
1490	"	"	Quartz	2	Herkimer Co. N. Y		Showing empty cavities
1491	"	"	Muscovite	2	St. Lawrence, N. Y		
1492	"	"	Calcite	4	Rossie, N. Y		
1493	"	"	Serpentine	3	Montville, N. J		
1494	"	"	Apophyllite containing Ripidolite (Chlorite)	1	Bergen Hill, N. J		
1495	"	"	Copalite (with insects)	2	Zanzibar, Africa		
1496	"	"	Pyrite (auriferous)	1	Queensland		With Chalcopyrite
1497	"	"	Antimony (from Stibnite)	1	Victoria		
1498	"	"	Corundum (Sapphire)	1	Vernon, N. J		
1499	"	"	Mesolite and Calcite	4	Bergen Hill		
1500	"	"	Gmelinite on Datolite	2	Bergen Hill		White and rare
1501	"	"	Apophllyte and Stilbite	1	Bergen Hill, N. J		
1502	"	"	Calcite (Dog Tooth Spar)	5	Missouri		
1503	"	"	"Satin Spar"	2	Wales		
1504	"	"	Naumannite on Garnet	4	Victoria, Australia		
1505	"	"	Pyroxene	1	Lewis Co, N. Y		
1506	"	"	Calcite (Spartaite)	1	Sparta, N. J		
1507	"	"	Red and Green Tourmaline	2	Minas Geras, Brazil		
1508	"	"	Wollastonite	1	Near Haverstraw, N. Y		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1509	Nov. 1876	Geo. F. Kunz	Thomsenolite	1	Tvigtut, Greenland		
1510	"	"	Smithsonite	1	Zinc Co., Mo		
1511	"	"	Pyrite and Galenite	1	Rossie, N. Y		
1512	"	"	Spinel and Corundum	1	Franklin, N. J		
1513	"	"	Franklinite, Zincite and Rhodochrosite (Dialogite.	1	Franklin, N. J		
1514	"	"	"Scapolite" on Amphibole (Hornblende)	1	Franklin, N. J		
1515	"	"	Stilbite	2	Southbury, Connecticut		
1516	"	"	Green Tourmaline	2	Franklin, N. J		
1517	"	"	Manganite	1	Franklin, N. J		
1518	"	"	Wernerite	2	Lewis Co., N. Y		
1519	"	"	Vivianite (Mullicite)	1	Mullica Hill, N. J		
1520	"	"	Analcite (Analcime)	1	Nova Scotia		
1521	"	"	Seybertite (Clintonite)	3	Franklin, N. J		
1522	"	"	Scapolite and Phlogopite	1	Franklin, N. J		
1523	"	"	Barite	1	England		
1524	"	"	Schorlomite and Garnet	1	Magnet Cove, Ark		
1525	"	"	Halloysite (Indianaite)	1	Indiana		
1526	"	"	Unknown	1	Bergen Hill, N. J		
1527	"	"	Pyrite	1	Roxbury, Ct		
1528	"	"	Bornite and Chalcopyrite	1	Bristol, Ct		
1529	"	"	Gold Quartz	1	Victoria, Australia		
1530	"	"	Hematite (Specular Iron.)	1	Germany		
1531	"	"	"Sussexite," (Rare)	23	Franklin, N. J		
1532	"	"	Lepidolite	1	Hebron, Maine		
1533	"	"	Phillipsite in Trachyte	1	Italy		
1534	"	"	Chalcostibite (Antimonial Copper)	1	Chili		
1535	"	"	Garnet (Colophonite)	1	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME	No. of Specimens.	Locality	Formation	Collector and Remarks.
	When.	Whence.					
1536	Nov. 1876	Geo. F. Kunz	Willemite (Troostite) and Calcite (Spartaite)				
1537	"	"	Willemite and Calcite (Spartaite)				
1538	"	"	Franklinite and Calcite (Spartaite)				
1539	"	"	Franklinite and Rhodochrosite [Dialogite]				
1540	"	"	Soda Nitre [Nitratine]				
1541	"	"	Datolite [Massive]				
1542	"	"	Galenite				
1543	"	"	Galenite				
1544	"	"	Tourmaline				
1545	"	"	Prehnite and Copper				
1546	"	"	"Tvigtite"				
1547	"	"	Quartz [Amethyst]				
1548	"	"	Apophyllite and Pectolite [primitive]				
1549	"	"	Vanadinite [Crystallized]				
1550	"	"	Datolite and Yellow Stilbite				
1551	"	"	Pyrite				
1552	"	"	Orthoclase				
1553	"	"	Garnet				
1554	"	"	Brookite				
1555	"	"	Staurolite				
1556	"	"	Aluminite [Hallite]				
1557	"	"	Chlorastrolite				Rare in Rock
[illegible]	"	"	Azurite				
[illegible]	"	"	Stibiconite [Partzite and Stetefeldtite]				
[illegible]	"	"	Algodonite				
[illegible]	"	"	Cassiterite [Stream Tin]				
[illegible]	"	"	Brookite [Arkansite] and Rutile ? [Nigrine]				Small and numerous

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1563	Nov. 1876	Geo. F. Kunz	Brookite [Arkansite]	14	Magnet Cove, Ark		Small and numerous
1564	"	"	Topaz [rite.	10	Durango, Mexico		
1565	"	"	Titanite [Green Sphene] with Ripidolite [Chlo-	2	Tyrol		
1566	"	"	Rutile	9	Lynchburg, Va		
1567	"	"	Native Lead	1	Granada, Spain		
1568	"	"	Vivianite	5	Mullica Hill, N. J		
1569	"	"	Cassiterite [Stream Tin]	14	Durango, Mexico		
1570	"	"	Microlite	2	Chesterfield, Mass		
1571	"	"	Atacamite	1	Chili		
1572	"	"	Spinel [Ruby]	20	Franklin, N. J		
1573	"	"	"Stevensite"	5	Bergen Hill, N. J		
1574	"	"	Fibrous Malachite	1	Germany		
1575	"	"	Quartz	1			
1576	"	"	Mica and Spinel [Ruby]	1	Franklin, N. J		
1577	"	"	Amphibole [Hornblende]	1	Spain		
1578	"	"	Gismondite and Analcite	1	Cyclopean Islands		
1579	"	"	Laumontite and Datolite	2	Bergen Hill, N. J		
1580	"	"	Quartz [Carnelian]	1	Germany		
1581	"	"	Chrysocolla	6	Chili, S. A		
1582	"	"	Smoky Quartz	1	St. Gothard, Switzerl'nd		
1583	"	"	Chrysolite [Olivine]	3	Arizona		
1584	"	"	Quartz [Amethyst]	3	Brazil		
1585	"	"	Lapis-Lazuli	1	Siberia		
1586	"	"	"Black Mica"	2	New York City		
1587	"	"	Iridescent Franklinite and Willemite	1	Franklin, N. J		
1588	"	"	Opal	1	North Carolina		
1589	"	"	Ruby, Sapphire, &c	75	Franklin, N. J		Indefinite

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1590	Nov. 1876	Geo. F. Kuntz	Epidote	1	Tyrol, Europe		
1591	"	"	Quartz crystal penetrated by another crystal	1	Herkimer Co., N. Y		
1592	"	"	Talc [Steatite, Pseudo-after Staurolite]	1	Germany		
1593	"	"	Stromeyerite	1	Arizona		
1594	"	"	Quartz [Black Jasper]	1	Europe		
1595	"	"	Quartz [Sard or Carnelian]	1	Europe		
1596	"	"	Native silver	1	Mexico		
1597	"	"	Natrolite	1	Vesuvius, Italy		
1598	"	"	Green quartz containing ripidolite [Chlorite]	1	Olisville, N. Y		
1599	"	"	Calcite	1	Lake Superior		
1600	"	"	Quartz containing Psilomelane	1	Hot Springs, Ark		
1601	"	"	Opal	10	Hungary		
1602	"	"	Amphibole [Asbestus]	1	North Carolina... [Ark.		
1603	"	"	"Quartz Cappings."	3	40 m. from Hot Springs,		
1604	"	"	Columbite	10	Haddam, Ct		
1605	"	"	Quartz	28	Herkimer, Co., N. Y		
1606	"	"	Kalinite [Native Alum]	1	Mt. Morris, N. Y. city		
1607	"	"	Diamond	1	South Africa		
1608	"	"	Topaz [Colored]	Indf	Durango, Mexico		
1609	"	"	Topaz [doubly terminated]	1	" "		
1610	"	"	"Durangite."	Indf	" "		From stream—tin.
1611	"	"	Zircon	3	Franklin, N. J		
1612	"	"	"Syngenite"	1	Poland, Galacia		Very rare.
[illegible]	"	"	Iridosmine		Oregon		
[illegible]	"	"	Menaccanite [Titanic iron sand containing gold garnet and zircon	Indf	"		
1615	"	"	Menaccanite [Iserium]	Indf	Switzerland		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1616	Nov. 1876	Geo. F. Kuntz	Dioptase	1	Gherghes Steppes, Si-		
1617	"	"	Quartz [Agate and Chlorastrolite]	Indf	Isle Royal, L. S. [ber'a		
1618	"	"	Mellite [Honey Stone]	2	Thuringia		
1619	"	"	Silver [wire]		Mexico		
1620	"	"	Beryl	1	Siberia		
1621	"	"	Apatite	1	Rosse, N. Y.		
1622	"	"	Nytive Tellurium	1	Transylvania		
1623	"	"	Apatite	2			
1624	"	"	Topaz	7	Brazil		
1625	"	"	Andalusite [Chiastolite] [angite."	1	Massachusetts		
1626	"	"	Cassitere [stream tin] with topazes and "Dur-	Indf	Durango, Mexico		
1627	"	"	Amphibole [Amianthus]		North Carolina		
1628	"	"	Native copper	1	Lake Superior		From a fissure
1629	"	"	Geode	1	Iowa		
1630	"	"	Quartz [Chalcedony after wood]	1	California		
1631	"	"	Quartz [Silicified wood]	1	Nevada Co. Nev.		
1632	"	"	Asphaltum [Albertite]	3	Nova Scotia		
1633	"	"	Kieserite		Stassfurt, Germany		
1634	"	"	Glauberite		Laramie Plaines, U. S.		
1635	"	"	Picromerite]Kainite]		Stassfurt, Germany		
1636	"	"	Sylvite		" "		
1637	"	"	Tachhydrite		" "		
1638	"	"	Polyhalite		" "		
1639	"	"	Carnallite		" "		[of University of Va.
1640	"	"	Meteoric iron		Virginia		Fall of 1868 from Prof. Mallet,
1641	"	"	Gold	1	Nova Scotia		
1642	"	"	Orthaclase [Amazon Stone]	1	Pike's Peak, Col		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number	Obtained. When.	Obtained. Whence.	NAME	No. of Specimens	Locality	Formation	Collector and Remarks.
1643	Nov. 1876	Geo. F. Kunz		5			
1644	"	"		5			
1645	"	"		3			
1646	"	"		1			
1647	"	"	rite (Clintonite).	1			
1648	"	"		1			
1649	"	"		1			
1650	"	"		1			
1651	"	"		1			
1652	"	"	while hot	1			
1653	"	"		6			
1654	"	"		2			
1655	"	"		2			
1656	"	"		5			
1657	"	"	coal]	4			
1658	"	"		1			
1659	"	"		1			
1660	"	"		1			
1661	"	"		1			
1662	"	"		1			
1663	"	"		1			
1664	"	"		1			
1665	"	"		1			
1666	"	"	remolite]	1			
1667	"	"	and Quartz	1			
1668	"	"		2			
1669	"	"		1			

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1670	Nov. 1876	Geo. F. Kunz	Pyrite	1	Jeddo Coal Mines, Pa		
1671	"	"	Pyrite	1	Rossie, N. Y		
1672	"	"	Rutile	2	Lincoln Co., Georgia		
1673			Rutile	1	Lancaster Co., Pa		
1674	"	"	Black Tourmaline	1	Rossie, N. Y		
1675			Tourmaline	1	Haddam, Ct		
1676	"	"	"Black Mica"	1	Franklin, N. J		
1677	"	"	"Mica, magnetited"	3	New York City		
1678	"	"	Quartz	1	Dubuque, Iowa		
1679	"	"	Pyrite Sphaecrite (dodecahedral Blende)	1	Pike's Peak, Col		
1680	"	"	Magnetite (native Magnet)	4	Magnet Cove, Ark		
1681	"	"	Chalcanthite (native Sulphate of Copper)		Cornwall, England		
1682	"	"	Gypsum	3	Mammoth Cave, Ky		
1683	"	"	Kaolinite (Argilliform)	2	Woodbridge, N. J		
1684	"	"	Odd Quartz	1	Magnet Cove, Ark		
1685	"	"	Doubly Terminated Milky Quartz	1	Magnet Cove, Ark		
1686	"	"	Quartz	1	Phœnixville, Pa		
1687	"	"	Calcite	1	Lake Superior		Rock on which Duluth is built
1688	"	"	"Satin Spar"	4	Nova Scotia		
1689	"	"	Quartz in Calc. Sand Rock	7	Herkimer Co., N. Y		
1690	"	"	Asphaltum (Bitumen, on Quartz calc. Sand R'k	1	Herkimer Co., N. Y		
1691	"	"	"Mica, magnetited"	1	New Hampshire		
1692	"	"	Galenite	1	Colorado		
1693	"	"	Sphalerite (Blende)	2	Phœnixville, Pa		
1694	"	"	Tourmaline	6	Chester, Mass		
1695	"	"	Celestite	1	Mt. Gergenti, Sicily		
1696	"	"	Quartz (Amethyst) and Fluorite	1	England		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1697	Nov. 1876	Geo. F. Kunz	Halite	4	St. Martinsville, La		
1698	"	"	Halite	1	Utah Territory		
1699	"	"	Limonite after Pyrite	1	Pennsylvania		
1700	"	"	Sphalerite [Blende] and Galenite on Quartz	1			
1701	"	"	Gypsum [Selenite]	1	Cayuga Lake, N. Y.		
1702	"	"	Barite	1	Gibralter		
1703	"	"	Calcite [Calc Tufa]	1	Litchfield, N. Y.		
1704	"	"	Allanite	5	Franklin, N. J.		
1705	"	"	Jefferisite	4	Westchester,Ch'r Co.Pa		
1706	"	"	Muscovite	2	Jefferson Co. N. Y.		
1707	"	"	Jeffersite	2	Connecticut		
1708	"	"	Serpentine	1	Pennsylvania		
1709	"	"	Chalcocite [Sulphide of Copper] after Wood	1	New Mexico		
1710	"	"	Azurite and Malachite	1	"		
1711	"	"	Gypsum	1	Dubuque, Iowa		
1712	"	"	Amphibole [Tremolite] in Dolomite	2	Lee, Mass.		
1713	"	"	Garnet	1	Hanover, N. H.		1
1714	"	"	Strontianite	1	England		
1715	"	"	Magnesite [White, Compact]	1	Hoboken, N. J.		
1716	"	"	Malachite	3	Chili, S. A.		
1717	"	"	Gypsum [Alabaster]	1	Cape Breton, N. S.		
1718	"	"	Green Tourmaline	1	Paris, Maine		
1719	"	"	Limonite	1	Chestnut Hill,LanCo Pa		
1720	"	"	Calcite [" Rock Milk "]	1	Watertown, N. Y.		
1721	"	"	Gothite [Lepidocrocite]	1	Chestnut Hill, Pa.		
1722	"	"	Aragonite, "Mexican Onyx"	1	Mexico		
1723	"	"	Stilpnomelane [Chalcodite]	1	Sterling MineAnw'pNY		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1724	Nov. 1876	Geo. F. Kunz	Ægirite (Black)	1	40 mile w Mag. Cove, Ark		
1725	"	"	Euxenite	1	Norway		
1726	"	"	Embolite	1	Silver City, Colorado		The "Bogus Silver Ore" from
1727	"	"	Pyrite in Gneiss	1	New York City		Western Boulevard and 105 st.
1728	"	"	Rhodonite (Fowlerite)	1	Franklin, N. J.		N. Y. City caused great excite
1729	"	"	Chabazite (White)	1	Ausig, Bohemia		ment
1730	"	"	Anorthite (Indianite)	2	Chester, Mass.		
1731	"	"	Limonite (Bog Iron Ore, after Wood)	1	New York State		
1732	"	"	Calcite (Fibrous Carb. of Lime)	2	Chicopee, Mass.		
1733	"	"	Fluorite	1	Derbyshire England		
1734	"	"	Porphyry [dite	1	Spain		
1735	"	"	Cassiterite Fluorite and Lepidolite (Zinnwal-	1	Paris, Maine		
1736	"	"	Fetid Limestone	1	Massachusetts		
1737	"	"	Albite	2	New York City		
1738	"	"	Berthierite	1	Hayunge, Depar't of the Mosselle, France		
1739	"	"	Malachite	1	New Mexico		
1740	"	"	Prehnite	1	Tyrol		
1741	"	"	Serpentine (Williamsite)	1	Pennsylvania		
1742	"	"	Calcite (Dog-Tooth Spar) [domelane	1	Bergen Hill, N. J.		
1743	"	"	Cancrinite with Torbernite (Chalcolite) Lepi-	3	Litchfield, Me.		
1744	"	"	Triphylite	1	Grafton, Vr.		
1745	"	"	Titanite (Sphene, Lederite)	1	New York		
1746	"	"	Titanite (Lederite)	2	Franklin, N. J.		
1747	"	"	Limonite coating Pyrite	1	Pennsylvania		
1748	"	"	Phlogopite	1	Canada		
1749	"	"	Samarskite	1	North Carolina		
1750	"	"	"Zonochlorite"	1	Hudson Bay Territory		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1751	Nov. 1876	Geo. F. Kunz	Celestite on Sulphur	3	Mt. Girgenti, Sicily		
1752	"	"	Cryolite, Sphalerite and Pyrite	1	Ivigtut, Greenland		
1753	"	"	Garnet	1	New York City		
1754	"	"	Covellite	1	Chili		
1755	"	"	Asphaltum	1	Egypt		[furnace.
1756	"	"	Fluorite [Fluate of lime]	2	Columbia, Pa		In Furnace Slag, St. Charles
1757	"	"	Amphibole [Tremolite]	1	Hartz, Germany		
1758	"	"	Brucite	2	Hoboken, N. J		Of rare occurrence at Hoboken
1759	"	"	Vanadinite	1	Lead Hills, Scotland		
1760	"	"	Pyrite	2	England		
1761	"	"	Gypsum, [Selenite, single crystal.]	1	Paris, France		
1762	"	"	Gypsum, [Selenite, twin crystals]	1	"		
1763	"	"	Vesicular lava with chrysolite	1	Sandwich Islands		
1764	"	"	"Carbonite."	1	Near Richmond. Va		
1765	"	"	Peganite	2	Near Hot Springs, Ark.		
1766	"	"	Genthite on Chromite	1	Wood's mine Lane'r Co.		
1767	"	"	Blue Calcite [elane.	1	Lake Champlain...[Pa.		
1768	"	"	Cancrinite with Nephelite [Elæolite] Lepidom-	1	Litchfield, Me		
1769	"	"	Prehnite	1	Simsbuby, Conn.		
1770	"	"	Opal [Hyalite]	1	England		
1771	"	"	Calcite [Satin Spar]	1	Chicopee, Mass.		
1772	"	"	Limonite ["Pipe Ore."	2	Near Easton, Pa.		
1773	"	"	Hollowed Analcite	1	Bergen Hill', N. J. [Md.		
1774	"	"	Schistose Hematite	1	Bachman Val.Carrol Co.		
1775	"	"	Pyroxene [Augite] in Lava	1	Vesuvius, Italy		
1776	"	"	Margarodite	1	Chester, Mass		
1777	"	"	"From a zinc furnace"	1	Virginia		Forty per cent. zinc

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1778	Nov. 1876	Geo. F. Kunz	Melaconite (Tenorite)	1	Chili		
1779	"	"	Siderite (Sphero siderite)	1	New York City		
1780	"	"	Samarskite	1	North Carolina		Crystal
1781	"	"	Mimetite (Campylite)	1	Dry gill, England		
1782	"	"	Hubnerite	1	California		
1783	"	"	Celestite	1	Magnet Cove, Ark.		
1784	"	"	Tourmaline and oligoclase	2	Green Island, Lake Erie		
1785	"	"	Dolomite (Pearl spar) with Fluorite,	1	New York City		
1786	"	"	Grey Tephroite, Franklinite and zincite	1	Lockport, N. Y		
1787	"	"	Quartz (Chalcedony)	1	Franklin, N. J		
1788	"	"	"Jade"	1	Italy		
1789	"	"	Pyromorphite on quartz	1	Easton, Pa		
1790	"	"	Elaterite (Elastic Bitumen)	3	Phœnixville, Pa		
1791	"	"	Black Garnet containing schorlomite	1	Derbyshire, Eng		
1792	"	"	Radiated gypsum	1	Marseilles, France		
1793	"	"	Menaccanite in talc	1	Harford Co. Md		
1794	"	"	Quartz (Jasper)	1	Massachusetts		
1795	"	"	Talc	1	St. Lawrence Co., N. Y		
1796	"	"	Serpentine and Calcite (Argentine)	1	Montville, N. J		
1797	"	"	Enargite	1	Alpine Co., Cal		[Plaster of Paris came.
1798	"	"	Gypsum	1	Paris, France		Quarry from which the name
1799	"	"	Hydrodolomite	1	Westchester Co., N. Y		
1800	"	"	Phœnite	1	Lake Superior		
1801	"	"	Arsenic (native)	1	Germany		
1802	"	"	Vivianite	1	Monmouth Co., N. J		
1803	"	"	Wolframite (pseudo after Scheelite)	1	Connecticut		
1804	"	"	Calcite (Stalactite)	1	Dubuque, Iowa		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1805	Nov. 1876	Geo. F. Kunz	Quartz	2	Magnet Cove, Ark		
1806	"	"	Amphibole (Actinolite)	1	Holliston, Mass		
1807	"	"	Fluorite	1	Hardin Co., Ill		
1808	"	"	Sphalerite [Blende, showing cleavage]	1	Granby, Mo		
1809	"	"	Mineral Coal [Lignite Coal	1	Isthmus of Panama		
1810	"	"	Tourmaline [Indicolite] and Beryl [Goshenite]	1	Goshen, Mass		
1811	"	"	Witherite [radiated]	1	Newcastle, Eng		
1812	"	"	Chalcocite	1	Liberty Mine, Md		
1813	"	"	Dolomite [Pearl Spar]	1	Lancaster Co., Pa		
1814	"	"	Lesleyite	1	Newlin, Chester Co., Pa		
1815	"	"	Amphibole [Amianthus]	1	Harford Co., Md		
1816	"	"	Zircon	7	Buncome Co., N. C		
1817	"	"	Pinite [Giesekite]	1	Nat.Br'dg.Lewis Co.N.Y		
1818	"	"	" Porcelain Jasper"	1	Germany		
1819	"	"	Brookite [Arkansite, in quartz]	1	Magnet Cove, Ark		
1820	"	"	Zincite [Oxide of Zinc]	2	Franklin, N. J		From fused ore heap
1821	"	"	Green Wavellite	2	Hot Springs, Ark		
1822	"	"	Pink Spinel in Pyroxene [Sahlite]	1	Vernon, N. J		
1823	"	"	Adamite	1	Toulon, France		
1824	"	"	Pyroxene	1	Northern, N. Y		
1825	"	"	Radiated Ripidolite	2	New York City		
1826	"	"	Aragonite	1	Mt. Girgenti, Sicily		
1827	"	"	Brucite	1	Wood'sMine.Lan co.Pa.		
1828	"	"	Azurite and Malachite	3	Franklin, N. J		
1829	"	"	Pyromorphite	3	Phœnixville, Pa		
1830	"	"	Magnetite (magnetic iron sand)		Long Island Beach		
1831	"	"	Magnetite	5	Near Stockholm, N. J		Ogden mine

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Seiral Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1832	Nov. 1876	Geo. F. Kunz	Magnetite	3	Near Bloomington, N. J		
1833	"	"	Magnetite	3	Roseville, N. Y		
1834	"	"	Magnetite	1	Byrain, N. J		
1835	"	"	Magnetite	1	New Jersey		
1836	"	"	Magnetite	2	Woodsport, N. J		
1837	"	"	Magnetite	12	Franklin, N. J		
1838	"	"	Stibnite	3	Hungary		
1839	"	"	Petrified wood	1	Middle Park, Col		
1840	"	"	Petrified wood	1	Colorado		
1841	"	"	Petrified wood	1	Colorado		
1842	"	"	Siderite (Carbonate of Iron)	1	New York City		
1843	"	"	Asphaltum	1	Bex, Switzerland		
1844	"	"	Mineral Coal (Lignite) with Pyrite	1	Ohio		
1845	"	"	Result of decomposition of Pyrite	1	Bergen Hill, N. J		
1846	"	"	Tourmaline (bent crystals)	1	Cecil Co., Md		
1847	"	"	Chromite	1	Wood's mine, Lan. co. Pa		
1848	"	"	Cryolite with Siderite	1	Arksut Bay, Greenland		
1849	"	"	Cyanite	2	Newton, Conn		
1850	"	"	Limonite	10	Hamburg, N. J		
1851	"	"	Pyrite	1	Bergen Hill, N. J.		
1852	"	"	Galenite	1	Phœnixville, Pa		
1853	"	"	Magnetite	1	Dickinson Mine, N. J		
1854	"	"	Anthophyllite	1	Smithfield, R. I		
1855	"	"	Allanite (Orthite, crystals)	2	New York City		
1856	"	"	Ripidolite (Chlorite)	1	Franklin, N. J		
1857	"	"	Amphibole (Byssolite) and Ægirite	1	Hot Springs, Ark		
1858	"	"	Gothite (Feathery Lepidocrocite)	2	Chestnut Hill, Pa		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained: When.	Obtained: Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
1859	Nov., 1876	Geo. F. Kunz	Serpentine	1	Franklin, N. J.		
1860	"	"	Stilbite resembling Wavellite	1	Philadelphia, Pa.		
1861	"	"	Aragonite ... ite (Crystals	1	Franklin, N. J.		
1862	"	"	Garnet (Colophonite) and Rhodonite (Fowler	1	"		
1863	"	"	Brown Hematite	2	[illegible], Pa.		
1864	"	"	Calamine				
1865	"	"	Epidote on Orthoclase		}		
1866	"	"	"Scapolite"		}		
1867	"	"	Brookite				
1868	"	"	Native Copper		...o, Mich.		
1869	"	"	Calamine		...a.		
1870	"	"	Magnesite (Breunerite)		...s		
1871	"	"	Limonite and Smithsonite		...J.		
1872	"	"	Niccoliferous Pyrrhotite		...Pa.		
1873	"	"	Calcite (Argentine) and Serpentine		...J.		
1874	"	"	Enstatite (Bronzite)		...der Co., Pa.		
1875	"	"	Egirite		...Ark.		
1876	"	"	Hydromagnesite		..., Pa.		
1877	"	"	Jadeite				
1878	"	"	Domeykite				
1879	"	"	Copper in calcite		...r.		
1880	"	"	Hydrodolomite (Pennite)		...Pa.		
1881	"	"	Ripidolite (Clinochlore)		...J.		
1882	"	"	Witherite on Water Lime				Only American locality
1883	"	"	Barite, Malachite and Quartz				
1884	"	"	[illegible]				
1885	"		Malachite in Ochre				

Serial Num	When.	Whence.	NAME.	No. of Spe	Locality.	Formation	Collector and Remarks.
1886	Nov. 1876	Geo. F. Kunz	Flesh-colored Quartz Rock	1	Burlington, Vt.		
1887	"	"	Pele's Hair	Indf	Sandwich Islands		
1888	"	"	"Mica"	3	Franklin, N. J		
1889	"	"	Datolite (Oil green variety)	1	Bergen Hill, N. J		
1890	"	"	Prehnite with vein of "Stevensite"	1	"		
1891	"	"	Gœthite (Lepidocrocite)	1	Chestnut Hill, Pa.		
1892	"	"	Tourmaline	1	Chester, Mass.		
1893	"	"	Red Hematite	1	Franklin, N. J.		
1894	"	"	Graphite	35	New Jersey		
1895	"	"	Arsenopyrite (Mispickel)	1	Roxbury, Ct.		
1896	"	"	Dendrite	1	Franklin, N. J		
1897	"	"	Feldspar on Trap	1	Bergen Hill, N. J		
1898	"	"	Gold in Quartz	1	California		
1899	"	"	Seybertite (Clintonite) and Chalcopyrite	1	Franklin, N. J		
1900	"	"	Epidote, Orthoclase and Copper	1	Lake Superior		
1901	"	"	Siderite	1	England		
1902	"	"	Fluorite	1	Mine Hill, Franklin, N. J		
1903	"	"	Penninite	1	Lows Mine, Tex. Lan. Co		Lows Mine
1904	"	"	Green Quartz	1	Staten Island N. J. [Pa		
1905	"	"	Zircon on Feldspar	1	Diana N. J.		
1906	"	"	Magnesite	1	Hoboken N. J.		
1907	"	"	Sodalite	1	Salem, Mass. [N. J.		
1908	"	"	Willemite	1	Passaic Mine, Franklin,		
1909	"	"	Orthoclase and Epidote	1	New York City		
1910	"	"	"Mica"	1	Chesterfield, Mass.		
1911	"	"	Aragonite	2	Franklin, N. J.		
1912	"	"	Turgite (Hydrohematite)	2	Chestnut Hill, Pa.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained: When.	Obtained: Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1913	Nov. 1876	Geo. F. Kunz	Pectolite and Datolite	1	Bergen Hill, N. J.		
1914	"	"	Goethite (Lepidocrocite)	1	Chestnut Hill, Pa.		
1915	"	"	Magnetite (Native magnet)	1	Union Town, N. J		
1916	"	"	Ruby zinc, Dialogite and "Sussexite"	1	Franklin, N. J		
1917	"	"	Brookite (Arkansite)	1	Magnet Cove, Ark		
1918	"	"	Apophyllite and Stilbite	1	Bergen Hill, N. J		
1919	"	"	Apophyllite and Datolite	2	" "		
1920	"	"	Apophyllite (modified)	1	" "		
1921	"	"	Laumontite	2	" "		
1922	"	"	Titanite (Sphene)	1	Amity, N. Y.		
1923	"	"	Tourmaline	1			
1924	"	"	Fossiliferous Hematite	1	Oneida, N. Y.		
1925	"	"	Analcite, Apophyllite and Natrolite	1	Bergen Hill, N. J.		
1926	"	"	Rhodonite	2	Cummington, Mass		
1927	"	"	Muscovite	2	New Hampshire		
1928	"	"	Rhodonite (Cummingtonite)	1	Cummington, Mass		
1929	"	"	Chrysocolla and green quartz	1	Chili, S. A.		
1930	"	"	Melanterite (native copperas)	1	Staten Island, N. Y.		From iron mine
1931	"	"	Copper on quartz	1	Lake Superior, Mich		Central mine
1932	"	"	Garnet (Colophonite)	1	Franklin, N. J.		
1933	"	"	Quartz (Silicified wood)	1	Southern Georgia		Not found in any other locality and not described in books. Very handsome, polished across the cut concretions.
1934	"	"	Wenerite (Lilac Scapolite)	1	Bolton, Mass.		
1935	"	"	Garnet	1	New Jersey		
1936	"	"	Calcite (concretionary marble) on fetid limestone.	1	Holyoke, Mass.		
1937	"	"	"Montebrasite."	1	Montebras, Creuse Fr.		
	"	"	Gold and Silver ore	1	East Creek, N. J.		Belden's Mine.
	"	"	Calcite (dog-tooth spar) and Dolomite (Pearl spar.)	1	Lockport N. Y.		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks
1940	Nov. 1876	Geo. F. Kunz	Datolite (in small crystals)	1	Bergen Hill, N. J.		
1941	"	"	Lepidolite.	1	Alterberg, Saxony		
1942	"	"	Calcite	1	Warwick, N. Y		
1943	"	"	Slag from Furnace	1	Patterson, N. J.		
1944	"	"	Calcite	1	Bellville, N. J		From old copper mine.
1945	"	"	Iridescent Pyrite	1	Scales Mound, Galena Ill		
1946	"	"	Amphibole (actinolite)	1	Black Horse, Del		
1947	"	"	Amphibole (actinolite)	2	63rd St New York City.		
1948	"	"	Orthoclase (Amazon stone)	1	Mineral Hill, Pa.		
1949	"	"	Calcite, Pyrite and Specular iron	1	Antwerp, N Y		
1950	"	"	Amygdaloid containing zeolites	1	Poonah, Hindostan		
1951	"	"	Gangue rock of Cassiterite (Tinstone)	1	Durango, Mexico		
1952	"	"	Opal	1	Rocky Mountains		
1953	"	"	Sphalerite (with Bitumen and Galenite).	1	Oronogo, Mo		
1954	"	"	Topaz (yellow)	1	Brazil, S. A		
1955	"	"	Quartz coated with Smithsonite (carb of zinc)	1	Chatham N. Y		
1956	"	"	Opal	1	Mexico		
1957	"	"	Apophyllite	1	Bergen Hill, N. J.		Changing to Thomsonite.
1958	"	"	Staurolite	1	Lisbon, N. Hampshire		
1959	"	"	Chrysolite (Olivine).	1	Dries Eifel, Europe		
1960	"	"	Quartz	1	Governeur, N. Y		Without lateral planes.
1961	"	"	Quartz	1	Antwerp, N. Y.		Without lateral planes.
1962	"	"	Topaz (pink)	1	Brazil, S. A.		
1963	"	"	Gold	1	Virginia		
1964	"	"	Siderite and quartz in Geode.. .[Specular iron.	1	Illinois		
1965	"	"	Quartz without lateral planes and Hematite,	1	Cumberland, Eng.		
1966	"	"	Quartz and chalcopyrite	1	Ellenville, N. J.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1994	Nov. 1876	Geo. F. Kunz	Magnetite (Loadstone)	75	Magnet Cove, Ark		
1995	"	"	Magnetite (Sand) [(Jeffersonite)	1	Port Ontario, N. Y		
1996	"	"	Brown Garnet and Iron Garnet on Pyroxene	1	Franklin, N. J		
1997	"	"	Orthoclase (Chesterlite)	1	Chester Co., Pa	[group	
1998	"	"	Gypsum (Selenite)	1	Lockport, N. Y	Niagara	
1999	"	"	Crystallized Pectolite	10	Bergen Hill, N. J.		
2000	"	"	Laumontite and Crystallized Pectolite	3	Bergen Hill, N. J		Very rare
2001	"	"	Wulfenite	1	Tecoma Mine, Utah		
2002	"	"	Quartz (Yellow Jasper)	1	California		
2003	"	"	Calamine, Sphalerite and Greenockite	2	Granby, Mo		
2004	"	"	Chlorastrolite	2	Isle Royal, Lake Sup		Rare, in rock
2005	"	"	Sphalerite (Blende) and Quartz	1	Phœnixville, Pa		
2006	"	"	Black Tourmaline	1	Kingsbridge, N. Y. City		
2007	"	"	Zincite (with Calcite)	1	Franklin, N. J		
2008	"	"	Brucite (Nemalite)	1	Hoboken, N. J		
2009	"	"	Amphibole (Hornblende) in Quartz	2	Chester, Mass		
2010	"	"	Zaratite	1	Wood's Mine, Lan. co. Pa		
2011	"	"	Epidote	1	Massachusetts		
2012	"	"	Orthoclase (Flesh colored Feldspar)	2	New York City		
2013	"	"	Oligoclase	1	New York City		
2014	"	"	Seybertite (Clintonite)	1	Franklin, N. J		
2015	"	"	Zincite (with Calcite) "Sussexite"	1	Franklin, N. J		
2016	"	"	Greenockite	1	Granby, Mo		Of the following Nos. to No. 2003,
2017	"	"	Siderite	1	Roxbury, Conn		nearly all were collected by
2018	"	"	Gmelemite	1	Bergen Hill, N. J		[Chas. Clifton, about 1800, from
2019	"	"	"Feldspar"	1	Chester, Pa		near Easton, Pottsville, and the
2020	"	"	Limonite	24	Near Easton, Pa		coal and iron district bordering.

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2021	Nov. 1876	Geo. F. Kunz	Limonite [Fibrous]	5			22
2022	"	"	Limonite	9	Cu		
2023	"	"	Limonite [Stalactitic]	1			
2024	"	"	Limonite	4			
2025	"	"	Limonite	2			
2026	"	"	Limonite	4			Allegheny Furnace
2027	"	"	Limonite	5			
2028	"	"	Limonite	2	Pa		
2029	"	"	Limonite [septaria of]	1			
2030	"	"	Limonite [fossil]	2			
2031	"	"	Limonite [fossil]	3			
2032	"	"	Limonite [fossil]	1			
2033	"	"	Limonite [fossil]	1			
2034	"	"	Hematite [Red]	3			
2035	"	"	Hematite [brown]				
2036	"	"	Hematite [brown]		Pa		
2037	"	"	Hematite [fossil]				
2038	"	"	Hematite [fossil]				
2039	"	"	Hematite [fossil]				
2040	"	"	Hematite [fossil]		Pa		
2041	"	"	Hematite [fossil]	[illegible]			
2042	"	"	Hematite [fossil]				
2043	"	"	Hematite [fossil]				Cumberland Furnac
2044	"	"	Hematite				
2045	"	"	Siderite		Pa.		
2046	"	"	Siderite [Shale]	1	Pa.		
2047	"	"	Siderite and Limonite	1	Pa.		

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
							23
2048	Nov. 1877	Geo. F. Kunz	Siderite	1	Hopewell, Pa		Siliceous
2049	"	"	Siderite	2	Easton, Pa		
2050	"	"	Hematite (Specular Iron]	2	Lake Superior Region		
2051	"	"	Hematite (Specular Iron)	1	Near Pottsville, Pa		
2052	"	"	Hematite (Specular Iron)	2	Near Easton, Pa		
2053	"	"	Hematite (Specular Iron)	1	Pottsville, Pa		
2054	"	"	Pipe Ore	1	Pottsville, Pa		Bay Ridge Mountain Coal Field
2055	"	"	Calcite and Siderite	1	Easton Pa		
2056	"	"	Magnetite	4	Mt. Hope, N. J		
2057	"	"	Magnetite	2	Dover, N. J		
2058	"	"	Magnetite (Magnetic Iron)	1	Cornwall, Leban'n co Pa		
2059	"	"	Magnetite and Pyrite	2	" "		
2060	"	"	Magnetite and Pyrite	1	" "		
2061	"	"	Pyrite	1	Near Easton, Pa		
2062	"	"	Magnetite ?	3	Cornwall, Leban'n co Pa		
2063	"	"	Iron Ore	1	Bedford county, Pa		
2064	"	"	Sodalite with Cancrinite and Lepidomelane	1	Litchfield, Me		
2065	"	"	Peculiar Slags from Furnaces	2	Alleghany, Pa		Same Note Applies as to No. 2020
2066	"	"	Calcite (Flux)	1	Easton, Pa		" " " " 2020
2067	"	"	Slag Crystals from Furnaces	1	Easton, Pa		" " " " 2020
2068	"	"	Mineral Coal (Anthracite)	2	Pottsville, Pa		" " " " 2020
2069	"	"	Beryl (Aquamarine)	1	Liberia		
2070	"	"	Cassiterite (Stream Tin) and Topazes	Indf	Durango, Mexico		
2071	"	"	Cassiterite (Stream Tin)	Indf	Durango, Mexico		
2072	"	"		1			Believe it Artifi. (G. F. K.) As 2020
2073	"	"	Siderite (Carb. of Iron, Shale	2	Mt. Savage, Pa		Same Note Applies as to 2020
2074	"	"		1	Summit Furnace, Pa		" " 2020

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained: When	Obtained: Whence	Name	No. of specimens	Locality	Formation	Collector and Remarks.
2075	Nov. 1876	Geo. E. Knaz	"Fire Clay"	2	Mt. Savage, Pa		Same note applies as to 2020
2076	"	"	Coal Shale	1	Pottsville, Pa		Same note as 2020, about 80 feet above main view
2077	"	"	Limestone Ore (No. 1)	1	"		The following six are mine near Pottsville.
2078	"	"	"Slate Pins" (No. 2)	1	"		About 4 feet above main
2079	"	"	"Sandy Pin" (No. 3)	1	"		" 31 "
2080	"	"	"Fine Pin" (No. 4)	1	"		" 20 "
2081	"	"	"Upper Bastard (No. 5)	1	"		" 17 "
2082	"	"	"Pin Vein of Ore" (No. 6)	1	"		" 17 "
2083	"	"	(No. 7)	1	"		With 4 fluid cavities mark
2084	"	"	Quartz	1	Near Hot Springs, Ark		
2085	"	"	Calamine (blue)	2	Franklin, N. J		Crystal showing "O pla
2086	"	"	Calcite	1	Bergen Hill, N. J		
2087	"	"	Microlite and Uraconite (Uranochre)	1	North Carolina		
2088	"	"	Chloritoid (Masonite)	1	Smithfield, R. Island		
2089	"	"	Apatite, Pyrite and Graphite	1	Franklin, N. J		
2090	"	"	Quartz and Epidote	1	"		
2091	"	"	Calcite coated with quartz (Chalcedony)	1	Bergen Hill, N. J		
2092	"	"	Decomposing Pectolite and Prehnite	1	" "		
2093	"	"	Chalcopyrite	1	" "		
2094	"	"	Pseudo Talc (Steatite)	1	" "		
2095	"	"	Franklinite and Calcite	2	Franklin, N. J.		
2096	"	"	Franklinite and Calamine	1	" "		
2097	"	"	Wernerite (Scapolite) and Apatite	1	" "		
2098	"	"	Oligoclase	1	New York City		
2099	"	"	Amphibole (Asbestus)	5	Franklin, N. J		
2100	"	"	Labradorite	1	Louis County, N. Y		
[illegible]	"	"	Graphite and some other mineral	1	New York		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2102	Nov. 1879	Geo. F. Kunz	Catlinite	1	Pipestone Co., Minn		
2103	"	"	Quartz containing fluid and mineral coal (Anth.)	1	Herkimer Co., N. Y		
2104	"	"	Barite	1	Franklin, N. J		
2105	"	"	Spodumene	1	Maine		
2106	"	"	Zincite and Calcite Spartaite	1	Franklin, N. J		
2107	"	"	Garnet on Zincite (Schist)	4	Franklin, N. J		
2108	"	"	Franklinite, Zincite and Calcite (Spartaite)	1	Franklin, N. J		
2109	"	"	"Mica"	1	Chester, Pa		
2110	"	"	Pyrite (octahedral)	2	Bergen's Hill, N. J		
2111	"	"	Quartz (Amethyst, doubly terminated)	6	Brazil		
2112	"	"	Perofskite	4	Magnet Cove, Ark		
2113	"	"	Pyroxene (in lava)	15	Vesuvius, Italy		
2114	"	"	Brucite	2			
2115	"	"	Calcite (Stalactite)	2			
2116	"	"	Serpentine	1	St. Lawrence Co., N. Y.		
2117	"	"	Calamine on Sphalerite	1	Granby, Mo		

INDEX TO THE GEOLOGICAL REPORT.

AGE.

PAGE

On page 3, insert "the" before Geological.

On page 3, for "Dec. 31, 1877," read May 25, 1878.

On page 27, fifth line from top, for "lining" read limy.

On page 28, first line from top, for "6.44" read 6.21.

On page 28, first line from top, for "32.287" read 31.287.

On page 28, second line from top, last column in table, for "0" read 9.

On page 43, for "Reconnoisences" read Reconnoissances.

On page 48, eighth line from bottom, for "moutone-ed" read *moutonne-ed*.

On page 53, second line from bottom, for "scantly" read scantily.

On page 55, third line from bottom, for "60" read 27.

On page 59, twelfth line from bottom, for "nolithic" read neolithic.

On page 68, third line from the top, for "Thus" read This.

The 69th and 70th pages should exchange places.

On page 75, at bottom, add Ilex verticellata, *Gray*, Black alder.

On page 82, fourteenth line from top, for "Chæteets" read Chætetes.

On page 83, twenty-fourth line from the bottom, for "organized" read recognized.

On page 99, seventeenth line from bottom, for "southwestern" read southeastern.

On page 123, third line from top, for "exposuse" read exposure.

On page 123, sixth line from top, for "mills" read miles.

On page 129, fourth line from bottom, for "62" read 52.

On page 201, strike out "Rock on which Duluth is built."

On page 216, the words "with 4 fluid cavities marked with ink," and "crystal showing 'o plane of Dana," should each be placed a line lower on the page.

ANNUAL REPORT

THE BOARD OF REGENTS

UNIVERSITY OF MINNESOTA,

ANNUAL REPORT

OF

THE BOARD OF REGENTS

OF THE

UNIVERSITY OF MINNESOTA,

To the Governor,

FOR THE

FISCAL YEAR ENDING DECEMBER 29th, 1878.

TRANSMITTED TO THE LEGISLATURE OF THE TWENTY-FIRST ANNUAL SESSION, 1879.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1879.

THE UNIVERSITY OF MINNESOTA,
OFFICE OF THE BOARD OF REGENTS,
December 27th, 1878.

To His Excellency, John S. Pillsbury,
Governor of Minnesota:

SIR:—In compliance with the law I have the honor to forward herewith the annual report of the Board of Regents for the fiscal year ending this day.

Very respectfully,
Your obedient servant,
HENRY H. SIBLEY,
President.

THE BOARD OF REGENTS

appointed by the Governor by and with the consent of the **Senate:**

The Hon. HENRY H. SIBLEY, St. Paul..............................**1879.**
The Hon. THOS. S. BUCKHAM, M. A., Faribault......................**1879.**
The Hon. PARIS GIBSON, M. A., Minneapolis........................**1880.**
The Hon. MORRIS LAMPREY, M. A., St. Paul........................**1880.**
The Hon. RICHARD CHUTE, Minneapolis.............................**1880.**
The Hon. WILLIAM R. MARSHALL, St. Paul..........................**1881.**
The Hon. A. A. HARWOOD,..**Resigned.**

and ex officiio,

The Governor of the State,

The Hon. JOHN S. PILLSBURY, **Minneapolis.**

The Superintendent of Public Instruction,

The Hon. D. BURT, M. A., St. **Paul.**

The President of the University,

WILLIAM W. FOLWELL, M. A., **Minneapolis.**

OFFICERS OF THE BOARD.

Hon. HENRY H. SIBLEY, President.
Hon. PARIS GIBSON, Recording Secretary and Treasurer.
WILLIAM W. FOLWELL, Corresponding Secretary.

THE ANNUAL MEETING

of the Board is fixed by law for the second Tuesday of Decemb
each and every year.

OFFICERS AND EMPLOYEES.

FOR THE UNIVERSITY YEAR ENDING JUNE 6TH, 1878.

OFFICERS OF INSTRUCTION.

WILLIAM W. FOLWELL, PRESIDENT,
Social Science and Logic.

G. CAMPBELL, M. A., B. D., VICE PRESIDENT AND PROFESSOR,
Mental and Moral Philosophy.

JABEZ BROOKS, M. A., D. D., PROFESSOR,
Greek Language and Literature.

EDWIN J. THOMPSON, M. A., PROFESSOR,
Mathematics and Astronomy.

NEWTON H. WINCHELL, M. A., PROFESSOR,
Geology and Mineralogy.

CHARLES N. HEWITT, M. D., PROFESSOR, (non-res.,)
Public Health and Hygiene.

MITCHELL D. RHAME, B. A., PROFESSOR,
Civil and Mechanical Engineering.

STEPHEN F. PECKHAM, M. A., PROFESSOR,
Chemistry and Physics.

JOHN G. MOORE, B. A., PROFESSOR,
North European Languages.

MOSES MARSTON, M. A., PROFES
English Language and Literature.

RICHARD W. LAING, LL. D., PROF
History and French.

JOHN A. LUNDEEN, U. S. A.,
Military Science and Tactics.

CHARLES Y. LACY, B. AGR., ASST. PR
Theory and Practice of Agriculture

LOUIS W. PECK, INSTRUCTOR,
Physics and Drawing.

MRS. AUGUSTA N. SMITH, PRECEP
English and History.

JOHN C. HUTCHINSON, B. A., INST
Greek.

JOHN S. CLARKE, B. A., INSTRUC
Latin.

MATILDA J. CAMPBELL, B. L., INST
English and German.

Dr. Henry C. Leonard was employed during the give instruction in Botany and Physiology.

Mr. C. W. Hall took the class in Historical Ge third week of the third term—relieving Prof. Winc work of the Geological survey.

EMPLOYEES.

JOHN B. EUSTIS, Farmer, *until April 1st.*
SAMUEL S. EUSTIS, Jr., Farmer, *after Apr*
GRAHAM C. CAMPBELL, B. A., Assistant L
CLARENCE C. HERRICK, Assistant in Muse
FRED. C. BOWMAN, Assistant in Chemical
J. CLARENCE BRYANT, Janitor of Main B
GEO. A. WOOD, Janitor of Agricultural Co
tant in the Plant House.
WM. H. SAVIDGE, Carpenter.
EVAN R. PRICHARD, Chorister.
WM. H. CHAMBERS, Fireman, Main Building.

All of the above employees are or have been students

OFFICIAL CHANGES.

The only change in the Board of Regents was the re-appointment by the Governor, with the advice and consent of the Senate, of Regent Marshall, for the term of three years.

At the spring meeting of the Board the following new elections were made, to have effect from and after the beginning of the next ensuing' university year:

Assistant Professor Chas. Y. Lacy was promoted to the rank of professor.

Instructor Louis W. Peck was elected assistant professor and the department of physics placed in his charge.

Mr. R. H. Tripp, of Michigan, was elected assistant professor to have charge of the Latin Language and Literature. This election has had the effect to relieve Professor Brooks of the care of the Latin department, which he has efficiently conducted in addition to his own work in the department of Greek since the death of Proessor V. J. Walker, in 1875. The board have reason to believe that the department in question will maintain its high excellence under its new chief.

Early in the third term Mr. C. W. Hall, well known as a successful teacher in the State, and for some time past a student of the University of Leipsic, was employed on a temporary engagement to give instruction in the department of Geology. This was found necessary, in order to relieve Professor Winchell, that he might proceed at an earlier date than usual to the field work of the Geological Survey.

At the meeting of the Board of Regents on commencement day, the matter of the Geological survey was further considered, and the Board decided that it was desirable to relieve the State Geologist from the work of teaching, in order to enable him to carry on the necessary duties of the Survey, and adopted resolutions to that effect. In pursuance of this action, Mr. C. W. Hall was employed to assist Professor Winchell in the field during the summer and fall, and to take charge of the instruction in Geology and Mineralogy, Botony and Zoology during the second and third terms.

COMMENCEMENT.

At the sixth annual commencement, held June 6th, 1878, sixteen degrees upon recommendation of the faculties were conferred. The whole number of graduates to date is fifty-two; males, forty-four, females, eight. The whole number of degrees conferred to date is

two per cent. upon the attendance of the previous year.

crease was to have been expected as a result of the abundant harvest of 1877, but it is believed that a large proportion of the addition was secured through the system of local examinations, first put in actual operation in the summer of that year. Under the authority of the Board a committee of the general faculty visited a number of the leading villages and cities, and held examinations for admission of the same nature and extent as those usually held at the University. In all cases the hearty co-operation of the county superintendents, principals and boards of education was extended. The candidates enjoyed the advantage of being examined in their usual places of study, unembarassed by the distractions of a long journey and strange surroundings. Very many young people resorted to these examinations who could not afford the expense of a journey to the University under the risk of failure and rejection. The expense to the Board was considerable, as the Treasurer's report will show; but it was very small in comparison with the united expenses of three hundred candidates.

The repetition of the local examinations in the summer of 1878, has proved as acceptable as the former ones, but the extensive disaster to the harvest has kept away many successful candidates, as well as a number of old students. The present prospect is that the attendance for the current year will not be much above three hundred and fifty. Under circumstances as favorable as those of the previous year there can be no doubt that it would have exceeded four hundred.

The Board are of opinion that the system may prove serviceable and acceptable for the future.

BUILDINGS.

No new erections have been made. The buildings are in good condition. The principal item of repair is the tin roof on the new addition to the main building. The slate roof which was laid when the building was erected has proved unserviceable in spite of repeated efforts to keep it in repair.

Early in the year insurance upon both buildings and their contents for seventy thousand dollars was effected at very favorable rates for five years in good companies, as follows:

the departments of chemistry, agriculture, and the classic

THE CAMPUS.

The Board feel it their duty to bring to the notice of your Excellency the subject of the enlargement of the campus, begun under the authority of the State, in compliance with the act for condemning private property for public purposes. These proceedings, begun years ago, should be closed at the earliest practicable day, in justice to the owners. The State must either provide the funds for paying in to the court the amounts awarded, or the proceedings must be abandoned and the project of enlargement given up.

The Board, therefore, respectfully renew their application for an appropriation of

THE GEOLOGICAL SURVEY.

For the earlier years of the enterprise it was deemed most advantageous to all concerned to confine the operations to the older and agricultural portion of the State. For some years past, however, there has seemed to be a reasonable demand that the mineral region supposed to lie in the north-eastern part of the State should be examined. In recognition of this demand the Board at the last annual meeting passed a resolution directing the State Geologist to visit this region during the succeeding summer. Prof. Winchell and Mr. Hall were accordingly occupied during the whole working season in exploring and examining the shore and parts of the interior of Lake Superior. Prof. Peckham was located for two months in Grand Marais, with suitable apparatus for assaying the precious metals. The reports of these officers are respectfully referred to for details of their operations. So far as any valuable discovery is concerned, the expectations of the Board have not been realized. Professor Winchell reports that "there is no actual mining being done in the State." The scientific results, however, are of great interest, and fully compensate for the expenses of the survey. The Geologists have identified the principal formations, and give directions for guidance to any seeking for silver, gold, copper or iron.

AGRICULTURAL COLLEGE AND FARM.

The report of Professor Lacy, detailing his experiments, is respectfully referred to for information.

At the agricultural fairs held in St. Paul, Minneapolis and Red Wing, in September last, a large and complete exhibit of the products of the farm was made by the professor in charge.

THE FRUIT FARM ON LAKE MINNETONKA.

It is proper to state that this enterprise originated with the members of the State Horticultural Society, who felt the need of having more systematic experiments in fruits than those conducted by themselves individually. Their deliberations led to the conviction that in connection with the Agricultural College these experiments could be most judiciously prosecuted.

Within a short time after the passage of the act referred to the Board undertook the duty prescribed. The tract of land of one hundred and sixteen acres, well-adapted to the purposes, has been secured.

Under the authority of the second section of the act you appointed Peter M. Gideon, of Hennepin county, to take charge of the farm and experiments. His work will show that a most promising beginning has been made.

FINANCES.

The report of the Treasurer of the University is herewith transmitted. All the items have been inspected and compared with the vouchers by the auditing committee, and the report has been approved and accepted by the Board.

The resources of the University consist of the income from sales of land granted by Congress, and appropriations of money by the State. The Treasurer's report exhibits the receipts and disbursements in detail,

The total accumulations of the productive fund derived from the sales of land and timber are reported by the State Auditor at $416,-187.74.

GENERAL OUTLOOK.

The Board respectfully report that the institution is in a satisfactory condition. The attendance, as already noted, for the academic year closing June last, was far in excess of that of any previous year.

The University is steadily and rapidly growing. The Board feel the importance of responding to the demands made by the people for the higher education of their children. To meet this requirement expenditures are inevitable, and many of the wants are immediate and pressing.

The reports of the President of University and other officers through him, are respectfully referred to for more definite information.

All of which is respectfully submitted.

TREASURER'S REPORT.

PARIS GIBSON, *Treasurer, in Account with the Board of Regents of the State University of Minnesota:*

CURRENT EXPENSE.

DR.

1877.				
Dec.	19,	To Cash from State Treasurer	$3,000 00	
1878.				
Jan.	4,	To Cash from State Treasurer	4,000 00	
Jan.	28,	To Cash from State Treasurer	3,500 00	
Feb.	28,	To Cash from State Treasurer	3,000 00	
Mar.	12,	To Cash from State Treasurer	1,000 00	
April	1,	To Cash from State Treasurer	3,000 00	
May	1,	To Cash from State Treasurer	3,000 00	
May	9,	To Cash from State Treasurer	1,000 00	
May	31,	To Cash from State Treasurer	4,000 00	
June	7,	To Cash from State Treasurer	1,300 00	
June	22,	To Cash from State Treasurer	700 00	
July	5,	To Cash from State Treasurer	3,500 00	
July	30,	To Cash from State Treasurer	1,200 00	
Aug.	22,	To Cash from State Treasurer	1,000 00	
Aug.	27,	To Cash from State Treasurer	1,000 00	
Sept.	21,	To Cash from State Treasurer	1,500 00	
Sept.	26,	To Cash from State Treasurer	3,000 00	
		To Transfer Museum acct. of '77 to Geological Survey	603 03	
Nov.	7,	To Cash from State Treasurer	2,000 00	
Nov.	29,	To Cash from State Treasnrer	2,800 00	
Dec.	9,	To Cash from State Treasurer	200 00	
Dec.	18,	To Cash from State Treasurer	1,100 00	
		To Balance Librarian's Fund	8 79	
		To Balance Student's Fees	969 65	
		By Disbursements		$46,087 19
		By Balance		294 28
			$46,381 47	$46,381 47

CR.

		By Balance from last Statement		$[illegible],227 [illegible]
1877.				
Dec.	22,	By Cash, Interest	Voucher No. 6.	15 [illegible]
1878.				
Jan.	5,	By Cash, Interest	" 24.	51 [illegible]
Jan.	25,	By Cash, Interest	" 42.	36 [illegible]
April	5,	By Cash, Discount	" 116.	1 [illegible]
April	12,	By Cash, Interest	" 187.	18 [illegible]
June	26,	By Cash, Interest	" 215.	16 [illegible]
Sept.	30,	By Cash, Interest	" 456.	25 [illegible]
		By Balance, Incidentals		3,200 [illegible]
		By Balance, Salaries for Instructors		26,1[illegible] [illegible]
		By Balance, Employees and Workmen		1,1[illegible] 25
		By Balance, Experimental Farm		1,[illegible] 45
		By Balance, Advertising		[illegible]
		By Balance, Repairs		1,[illegible]
		By Balance, Fuel		1,[illegible]
		By Balance, Plant House		[illegible]
		By Balance, Chemical Laboratory		75 [illegible]
		By Balance, Museum of Technology		[illegible]
		By Balance, Department of Physics		114 [illegible]
		By Balance, Library Expense		[illegible]
		By Balance, Library Faculty Fund		[illegible]
		By Balance, Library Reading Room		[illegible]
		By Balance, Insurance		[illegible]
		Disbursements		$46,[illegible] [illegible]

INCIDENTALS.

DR.

1878.			
Feb.	9,	To Cash, Letter Heads	$ 65
Feb.	26,	To Cash, Letter Heads	1 30
July	—,	To Cash, Freight	4 75
July	—,	To Cash, Pamphlet Boxes	1 50
July	—,	To Cash, Paper	3 50
Aug.	30,	To Cash, Lunn, Use of Stable	2 50
Sept.	30,	To Cash, Cook, Use of Stable	2 50

CR.

1877.				
Dec.	15,	By Cash, Oil and Brooms	Voucher No. 2.	$ 6 [illegible]
Dec.	15,	By Cash, Rowley	" 4.	20 [illegible]
Dec.	24,	By Cash, Brooks Bros	" 17.	17 [illegible]
1878.				
Jan.	3,	By Cash, Heath	" 22.	22 [illegible]
Jan.	5,	By Cash, Newton	" 23.	14 [illegible]
1877.				
Dec.	25,	By Cash, Smith	" 25.	10 [illegible]
1878.				
Jan.	1,	By Cash, Tribune Co	" 27.	1 [illegible]
Jan.	3,	By Cash, Paper	" 28.	12 [illegible]
Jan.	7,	By Cash, Stationery	" 30.	4 [illegible]
Jan.	16,	By Cash, Telegrams	" 32.	1 [illegible]
Jan.	10,	By Cash, Brooks Bros	" 33.	30 [illegible]
Jan.	17,	By Cash, Talbert & White	" 35.	[illegible]
Jan.	22,	By Cash, Glass	" 37.	[illegible]
Jan.	4,	By Cash, Perkins	" 39.	[illegible]

"	41.	16 50
"	46.	14 55
"	57.	4 92
"	58.	12 70
"	59.	2 50
"	65.	4 60
"	66.	2 50
"	74.	6 00
"	75.	6 00
"	88.	9 10
"	93.	9 30
"	103.	14 70
"	104.	16 55
"	112.	6 00
"	113.	9 30
"	120.	5 50
"	123.	58 75
"	124.	12 70
"	125.	24 44
"	126.	8 21
"	138.	29 16
"	149.	119 44
"	152.	4 15
"	163.	56 22
"	165.	20 00
"	179.	2 00
"	181.	3 00
"	183.	10 70
"	185.	6 44
"	186.	1 20
"	188.	1 53
"	192.	1 90
"	194.	59 38
"	195.	1 50
"	196.	6 00
"	197.	1 00
"	198.	8 10
"	201.	5 50
"	202.	16 65
"	203.	1 00
"	204.	5 00
"	206.	26 30
"	208.	8 00
"	216.	7 50
"	220.	17 50
"	222.	23 88
"	232.	136 66
"	233.	60 00
"	235.	5 50
"	236.	14 40
"	237.	15 00
"	238.	3 00
"	239.	55 00
"	244.	1 73
"	248.	17 25
"	252.	10 00
"	254.	34 80
"	257.	1 25
"	258.	4 85
"	259.	40 80
"	266.	4 75
"	267.	500 00
"	269.	70 65

July	16,	By Cash, Bryant	"	270.	57 00
July	31,	By Cash, Bryant	"	275.	20 00
July	30,	By Cash, Tribune Co.	"	276.	16 23
Aug.	9,	By Cash, Garden Rake, &c.	"	279.	1 35
Aug.	9,	By Cash, Cartage	"	280.	30 28
Aug.	9,	By Cash, Stationery	"	281.	19 58
July	30,	By Cash, Work on Campus	"	286.	58 17
July	6,	By Cash, Johnson & Smith	"	295.	436 00
Aug.	29,	By Cash, Bowman	"	301.	5 00
Aug.	31,	By Cash, Bryant	"	305.	25 00
Sept.	2,	By Cash, Savidge	"	307.	19 90
Sept.	2,	By Cash, Johnson & Smith	"	309.	33 00
Sept.	13,	By Cash, George A. Wood	"	311.	9 75
Sept.	23,	By Cash, Bryant	"	317.	
Sept.	23,	By Cash, Young & Patterson	"	318.	9 00
Sept.	23,	By Cash, Examinations	"	319.	76 05
June	—,	By Cash, Swett	"	331.	1 42
June	—,	By Cash, Cushman & Plummer	"	333.	5 75
June	4,	By Cash, Freight	"	335.	3 05
June	26,	By Cash, Newton	"	336.	19 50
July	1,	By Cash, Barnard & Cope	"	337.	5 00
July	1,	By Cash, Rockwood	"	338.	16 00
July	20,	By Cash, Col. Flagler	"	339.	2 00
July	19,	By Cash, Halvorsen	"	340.	1 50
July	19,	By Cash, Parker & Botsford	"	341.	1 50
Aug.	—,	By Cash, Henig	"	342.	2 00
Aug.	1,	By Cash, Globe	"	343.	3 00
Aug.	9,	By Cash, Walker	"	344.	3 00
Aug.	17,	By Cash, World	"	349.	3 75
Aug.	28,	By Cash, Directory	"	347.	3 00
Sept.	1,	By Cash, Dispatch	"	349.	3 00
Sept.	30,	By Cash, Rockwood	"	350.	20 90
Oct.	1,	By Cash, Newton	"	351.	4 00
Oct.	3,	By Cash, Savidge	"	352.	25 50
Oct.	3,	By Cash, Thompson	"	353.	3 00
Oct.	7,	By Cash, Janney, Moles & Brooks	"	354.	90
Oct.	9,	By Cash, Bryant	"	355.	3 45
Oct.	10,	By Cash, Geo. A. Wood	"	356.	1 65
Oct.	11,	By Cash, Lundeen	"	357.	1 75
Oct.	22,	By Cash, Savidge	"	358.	22 40
Oct.	23,	By Cash, Moore	"	359.	17 65
Oct.	1,	By Cash, Brooks Bros	"	361.	14 50
Oct.	1,	By Cash, Rockwood	"	362.	14 00
Oct.	7,	By Cash, Macy	"	372.	10 00
Oct.	7,	By Cash, Chambers	"	374.	8 10
Oct.	7,	By Cash, Hildreth	"	375,	8 00
Oct.	14,	By Cash, Thompson	"	378.	6 30
Oct.	17,	By Cash, Thompson	"	380.	35 46
Oct.	17,	By Cash, Thompson	"	381.	174 25
Oct.	17,	By Cash, Thompson	"	382.	9 00
Nov.	2,	By Cash, Bean, Chute & Wales	"	402.	15 08
Aug.	17,	By Cash, Eckman	"	412.	3 00
Nov.	12,	By Cash, Hawes & Smith	"	413.	10 65
		By Cash, Work on Campus	"	414.	57 42
Dec.	5,	By Cash, Rockwood	"	428.	3 50
Dec.	5,	By Cash, Rockwood	"	429.	9 50
June	20,	By Cash, Stamps	"	436.	43 00
Oct.	29,	By Cash, Pottle & Son	"	437.	50
Nov.	14,	By Cash, Freight	"	440.	8 23
Nov.	30,	By Cash, Lounsberry	"	442.	8 00
Dec.	3,	By Cash, Bachner Bros	"	443.	10 00
Dec.	3,	By Cash, Savidge	"	444.	10 23

By Cash, Rowley	Voucher No.	446.		2 00
By Cash, Stechard	"	447.		4 95
By Cash, Treasurer's Salary	"	453.		300 00
By Cash, Secretary's Salary	"	454.		100 00
By Cash, Stationery, &c.	"	455.		20 00
By Cash, Examination Expenses	"	469.		146 30
To Transfer to Student's Fees			$ 700 35	
To Balance, Current Expense			3,260 93	
			$3,977 98	$3,977 98

SALARIES FOR INSTRUCTION.

By Cash, Faculty	Voucher No.	7.		$2,295 00
By Cash, Bowman	"	8.		15 00
By Cash, Pritchard	"	9.		10 00
By Cash, Faculty	"	48.		2,295 00
By Cash, Bowman	"	49.		15 00
By Cash, Pritchard	"	50.		10 00
By Cash, Faculty	"	77.		2,395 00
By Cash, Bowman	"	79.		15 00
By Cash, Thompson	"	80.		25 00
By Cash, Pritchard	"	81.		10 00
By Cash, Lundeen	"	91.		250 00
By Cash, Miss Campbell	"	92.		200 00
By Cash, Faculty	"	95.		2,395 00
By Cash, Bowman	"	96.		15 00
By Cash, Pritchard	"	97.		10 00
By Cash, Dr. Hewitt	"	128.		50 00
By Cash, Faculty	"	129.		2,395 00
By Cash, Folwell	"	130.		400 00
By Cash, Bowman	"	131.		15 00
By Cash, Pritchard	"	132.		10 00
By Cash, Faculty	"	155.		2,395 00
By Cash, Bowman	"	160.		15 00
By Cash, Pritchard	"	161.		10 00
By Cash, Thompson	"	166.		25 00
By Cash, Faculty	"	168.		2,395 00
By Cash, Lundeen	"	169.		250 00
By Cash, Leonard	"	170.		200 00
By Cash, Miss Campbell	"	171.		100 00
By Cash, Bowman	"	175.		15 00
By Cash, Pritchard	"	176.		10 00
By Cash, Smith	"	190.		5 00
By Cash, Faculty	"	324.		2,530 00
By Cash, Miss Campbell	"	326.		60 00
By Cash, Bowman	"	330.		15 00
By Cash, Faculty	"	384.		2,530 00
By Cash, Bowman	"	385.		15 00
By Cash, Faculty	"	415.		2,530 00
By Cash, Lundeen	"	416.		83 33
By Cash, Miss Campbell	"	417.		140 00
By Cash, Bowman	"	418.		15 00
By Cash, Thompson	"	426.		25 00
To Balance to Current Expense			$26,188 33	
			$26,188 33	$26,188 33

EMPLOYEES AND WORKMEN.

1877.					
Dec.	24,	By Cash, Wood	Voucher No. 13.		$18 00
Dec.	24,	By Cash, Chambers	" 14.		30 00
Dec.	24,	By Cash, Bryant	" 15.		67 00
Dec.	1,	By Cash, Smith	" 20.		11 00
1878.					
Jan.	31,	By Cash, Bryant	" 51.		67 00
Jan.	31,	By Cash, Chambers	" 52.		30 00
Jan.	31,	By Cash, Wood	" 53.		18 00
Feb.	28,	By Cash, Chambers	" 83.		30 00
Feb.	28,	By Cash, Bryant,	" 84.		67 00
Feb.	28,	By Cash, Wood	" 85.		18 00
Mar.	31,	By Cash, Bryant	" 100.		67 00
Mar.	31,	By Cash, Chambers	" 101.		30 00
Mar.	31.	By Cash, Wood	" 102.		18 00
April	30,	By Cash, Bryant	" 135.		67 00
April	30,	By Cash, Wood	" 137.		18 00
May	3,	By Cash, Chambers	" 146.		75 00
May	31,	By Cash, Bryant	" 157.		67 00
May	31,	By Cash, Wood	" 159.		18 00
June	5,	By Cash, Rockwood	" 167.		12 06
June	6,	By Cash, Bryant	" 172.		67 00
June	6,	By Cash, Wood	" 174.		18 00
July	4,	By Cash, Hildreth	" 253.		26 00
Sept.	30,	By Cash, Bryant	" 325.		65 00
Sept.	30,	By Cash, Wood	" 329.		18 00
Oct.	31,	By Cash, Wood	" 387.		18 00
Oct.	31,	By Cash, Chambers	" 388.		45 00
Oct.	31,	By Cash, Bryant	" 389.		65 00
Nov.	30,	By Cash, Bryant	" 423.		65 00
Nov.	30,	By Cash, Chambers	" 424.		45 00
Nov.	30,	By Cash, Wood	" 425.		18 00
		To Balance to Current Expense		$1,182 25	
				$1,182 25	$1,182 25

EXPERIMENTAL FARM.

Dr.

1878.			
July	1,	To Cash, Farm Products	$432 16
Nov.	30,	To Cash, Farm Products	221 48
Nov.	30,	To Cash, Work on Campus	57 42

Cr.

1877.				
Dec.	24,	By Cash, Eustis,	Voucher No. 12.	$50 00
April	3,	By Cash, Eustis	" 114.	21 16
April	3,	By Cash, Eustis	" 115.	55 00
April	13,	By Cash, Thompson	" 112.	7 57
April	30,	By Cash, Eustis	" 136.	55 00
May	1,	By Cash, Eustis	" 139.	31 35
May	2,	By Cash, Munn	" 142.	15 [illegible]
May	3,	By Cash, Schmidt	" 147.	11 82
May	31,	By Cash, Eustis	" 153.	55 00
May	3,	By Cash, Eastwood	" 191.	6 25
May	7,	By Cash, Manchester	" 193.	9 00
May	21,	By Cash, Shumway	" 200.	15 [illegible]
June	1,	By Cash, Eustis	" 223.	30 15
June	1,	By Cash, Horses	" 224.	325 00
June	3,	By Cash, Shumway	" 226.	17 00
June	3,	By Cash, Munn	" 227.	23 [illegible]

June 24,	By Cash, Calladine	Voucher No. 247.			29 00
June 25,	By Cash, Plough	"	249.		17 00
July 1,	By Cash, Eustis	"	255.		55 00
July 18,	By Cash, Philips	"	262.		17 88
July 19,	By Cash, Linton	"	263.		16 18
July 20,	By Cash, Reynolds	"	265.		18 03
Aug. 5,	By Cash, Eustis	"	278.		55 00
July 31,	By Cash, Account Current	"	287.		33 83
July 31,	By Cash, Account Current	"	289.		636 96
Sept. 10,	By Cash, Manchester	"	293.		41 61
Aug. 30,	By Cash, Barret	"	304.		37 57
Sept. 2,	By Cash, Mahaffa	"	306.		16 00
Sept. 3,	By Cash, Eustis	"	310.		55 00
Sept. 28,	By Cash, Barret	"	320.		15 00
Sept. 30,	By Cash, Eustis	"	327.		55 00
Oct. 2,	By Cash, Budd	"	366.		20 00
Oct. 19,	By Cash, Drive Well	"	383.		10 00
Oct. 31,	By Cash, Eustis	"	386.		55 00
Nov. —,	By Cash, Account Current	"	409.		667 25
Nov. —,	By Cash, Swan	"	410.		11 37
Nov. —,	By Cash, Incidentals	"	411.		9 50
Nov. 30,	By Cash, Eustis	"	422.		55 00
Dec. 9,	By Cash, Geo. A. Wood	"	449.		9 72
	To Balance to Current Expense			$1,957 45	
				$2,668 46	$2,668 46

ADVERTISING ACCOUNT.

1877.					
Dec. 15,	By Cash, Ariel,	Voucher No. 1.			6 66
Dec. 22,	By Cash, Ariel	"	3.		6 66
Dec. 26,	By Cash, Farmers Union	"	18.		16 67
1878.					
Jan. 25,	By Cash, Ariel	"	43.		6 66
Jan. 11,	By Cash, Anti-Monopolist	"	40.		65 00
Feb. 16,	By Cash, Ariel	"	67.		6 66
Feb. 23,	By Cash, Farmers Union	"	72.		7 50
April	By Cash, yearly account	"	110.		353 40
April 5,	By Cash, Anti-Monopolist	"	117.		65 00
May 2,	By Cash, Ariel	"	141.		20 00
June 4,	By Cash, Ariel	"	230.		6 66
June 20,	By Cash, Anti-Monopolist	"	242.		62 50
June 1,	By Cash, Holliday	"	296.		3 00
Sept. 17,	By Cash, Ariel	"	314.		6 70
Sept. 30,	By Cash, Anti-Monopolist	"	323.		62 50
June,	By Cash, Freie Presse	"	332.		3 00
Oct. 29,	By Cash, Crist	"	360.		2 60
Oct. 4,	By Cash, Ariel	"	363.		13 32
Oct. 4,	By Cash Pioneer Press	"	371.		70 00
Oct. 7,	By Cash, Tribune	"	373.		15 75
Dec. 6,	By Cash, Ariel	"	430.		6 66
	To Balance to Current Expense			$806 90	
				$806 90	$806 90

REPAIRS ACCOUNT.

1877.					
Dec. 29,	By Cash, Savidge	Voucher No. 19.			30 56
Dec. 24,	By Cash, Cauvett & Co	"	16.		35 75
1878.					
Jan. 15,	By Cash, Williams	"	34.		1 95
Jan. 31,	By Cash, Savidge	"	47.		16 15
Feb. 28,	By Cash, Savidge	"	76.		13 65
April 1,	By Cash, Savidge	"	107.		8 25
April 1,	By Cash, Savidge	"	108.		12 50

May	3,	By Cash, Cauvett & Co	Voucher No. 144,		89 12
May	3,	By Cash, Cauvett & Co	" 145.		14 58
May	3,	By Cash, Farnham & Lovejoy	" 150.		18 57
May	21,	By Cash, Savidge	" 154.		13 95
March	25,	By Cash, Locks	" 180.		18 25
June	6,	By Cash, Curtain Fixtures	" 205.		1 55
June	15,	By Cash, Curtains	" 211.		20 00
June	18,	By Cash, Truesdall & Boutell	" 241.		12 35
July	20,	By Cash, Savidge	" 264.		46 56
Aug.	26,	By Cash, A. A. Pond	" 298.		400 00
Sept.	2,	By Cash, Donigsbear	" 308.		2 50
Sept.	17,	By Cash, J. W. Perkins	" 315.		24 19
Sept.	19,	By Cash, Chas. A. Bicknell	" 316.		127 68
Oct.	3,	By Cash, North Star Iron Works	" 368.		35 00
Oct.	12,	By Cash, Talbert & White	" 377.		17 70
Oct.	31,	By Cash, A. A. Pond	" 399.		500 00
Nov.	7,	By Cash, Cauvett & Co	" 407.		41 87
Nov.	9,	By Cash, St. Anthony Iron Works	" 408.		112 83
Dec.	18,	By Cash, Pond	" 452.		209 93
Nov.,		By Cash, Savidge	" 457.		13 09
Dec.	20,	By Cash, Rowley	" 465.		4 65
		To Balance to Current Expense		$1,843 18	
				$1,843 18	$1,843 18

INSURANCE ACCOUNT.

CR.

1878.					
July	10.	By Cash	Voucher No. 268.		$9 81
Mar.	3.	By Cash	" 94.		555 00
May	3.	By Cash	" 148.		75 00
Aug.	2.	By Cash	" 277.		180 00
		To Balance to Current Expense		$819 81	
				$819 81	$819 81

FUEL ACCOUNT.

CR.

Jan.	29.	By Cash, Lane	Voucher No. 45.		$22 00
Feb.	17.	By Cash, Lane	" 68.		21 00
May.	2.	By Cash, Northwestern Fuel Company.	" 143.		18 00
June	23.	By Cash, Hubbard	" 245.		63 00
Nov.	2.	By Cash, Mulford	" 400.		726 88
Nov.	7.	By Cash, Northwestern Fuel Company.	" 406.		618 75
		To Balance to Current Expense		$1,469 63	
				$1,469 63	$1,469 63

PLANT HOUSE ACCOUNT.

DR.

1878.			
July	1.	To Cash, Sales of Flowers	$64 23
Nov.		To Cash, Sales of Flowers	15 32

CR.

Jan.	2.	By Cash, Geo. A. Wood	Voucher No, 38.	23 30
Feb.	2.	By Cash, Geo. A. Wood	" 61.	21 02
Mar.	6.	By Cash, Geo. A. Wood	" 89.	22 85
April	2.	By Cash, Geo. A. Wood	" 111.	28 30
May	1.	By Cash, Geo. A. Wood	" 14[illegible].	33 82
July	22.	By Cash, Geo. A. Wood	" 271.	21 00

July	31.	By Cash, Account Current............. Voucher No. 288.			113 97
Sept.	13.	By Cash, Geo. A. Wood.................	" 312.		40 68
Oct.	3.	By Cash, Geo. A. Wood.................	" 369.		44 04
Nov.	4.	By Cash, Geo. A. Wood.................	" 404.		32 19
Dec.	9.	By Cash, Geo. A. Wood.................	" 450.		25 56
		To Balance to Current Expense........................		$337 78	
				$417 33	$417 33

CHEMICAL LABORATORY ACCOUNT.

Dr.

1878.				
June	6,	To Cash, From Students................................	$447 33	
June	6,	To Cash, Sales of Apparatus............................	25 70	
June	6,	To Cash, Discount for Analyses..........................	111 40	

Cr.

Dec.,		By Cash.............................. Voucher No. 448.		659 43
		To Balance to Current Expense........	75 00	
			$659 43	$659 43

DEPARTMENT OF PHYSICS.

Cr.

June	15,	By Cash, Account Current............. Voucher No. 214.		114 23
		To Balance to Current Expense.......	114 23	
			$114 23	$114 23

MUSEUM OF TECHNOLOGY.

Cr.

June	15,	By Cash, Account Current,............ Voucher No. 210.		23 37
		To Balance to Current Expense........	23 37	
			$23 37	$23 37

LIBRARY EXPENSE ACCOUNT.

1877.					
Dec.	24,	By Cash, Campbell...................... Voucher No. 11.			50 00
1878.					
Jan.	3,	By Cash, Miss Rollit....................	" 29.		6 98
Jan.	9,	By Cash, Freight........................	" 31.		380
Jan.	22,	By Cash, Express........................	" 36.		2 50
Jan.	31,	By Cash, Campbell.......................	" 54.		50 00
Feb.	5,	By Cash, Miss Rollit....................	" 62.		17 32
Feb.	6,	By Cash, Express........................	" 64.		1 00
Feb.	19,	By Cash, Freight........................	" 69.		5 42
Feb.	19,	By Cash, Express........................	" 70.		1 10
Feb.	26,	By Cash, Sundries.......................	" 73.		7 80
Feb.	28,	By Cash, Campbell.......................	" 82.		50 00
March	1,	By Cash, Miss Rollit....................	" 86.		18 60
March	31,	By Cash, Campbell.......................	" 99.		50 00
April	30,	By Cash, Campbell.......................	" 133.		50 00
May	30,	By Cash, Campbell.......................	" 158.		50 00
June	6,	By Cash, Campbell.......................	" 173.		50 00
April	1,	By Cash, Miss Rollit....................	" 184.		17 62
May	11,	By Cash, Miss Rollit....................	" 199.		19 27
June	4,	By Cash, Miss Rollit....................	" 231.		18 15
Sept.	14,	By Cash, Keyser.........................	" 313.		25 09
Sept.	30,	By Cash, Miss Rollit....................	" 328.		50 00
June,		By Cash, Miss Rollit....................	" 334.		5 62
Aug.	30,	By Cash, Miss Rollit....................	" 348.		6 07
Oct.	31,	By Cash, Miss Rollit....................	" 390.		50 00
Nov.	30,	By Cash, Miss Rollit....................	" 419.		50 00
		To Balance to Current Expense........		$656 34	
				$656 34	$656 34

LIBRARY FACULTY FUND.

Dr.

1878.				
Feb.	20,	To Cash, Dictionary	$8 75	
Feb.	26,	To Cash, German Book	1 00	
Oct.	—,	To Cash, J. G. Moore	33 37	

Cr.

Feb.	23,	By Cash, Foote	Voucher No. 151.		$18 72
Jan.	21,	By Cash, Foote	" 177.		24 30
Feb.	16,	By Cash, Foote	" 178.		71 00
April	1.	By Cash, Foote	" 182.		19 90
June	10,	By Cash, Freight	" 207.		3 98
June	15,	By Cash, Freight	" 213.		17 51
July	11,	By Cash, Pott, Young & Co.	" 200.		254 36
Aug.	8,	By Cash, Freight	" 344.		4 70
June	1,	By Cash, Van Nostrand	" 364.		8 00
Oct.	11,	By Cash, Casino	" 376.		40 17
Oct.	14,	By Cash, Pott, Young & Co	" 379.		316 06
Dec.	18,	By Cash, Books	" 451.		23 00
		To Balance to Current Expense		$758 58	
				$801 70	$801 70

LIBRARIAN'S FUND.

Dr.

1878.				
July	11.	To Cash, Interest	2 36	
July	12.	To Cash, Rockwood	30	
Nov.	1.	To Cash, Dictionary	8 85	
Nov.	1.	To Cash, Curtains	7 50	
Dec.	6.	To Cash, Interest	2 78	

Cr.

Nov.	1.	By Cash, Segner	Voucher No. 438.		3 00
Nov.	25.	By Cash, Smith	" 431.		10 00
		By Balance to Current Expense			8 79
				$21 79	$21 79

READING ROOM.

Dr.

May	8.	To Cash, Binders	1 14	
April	24.	To Cash, Binders	1 89	
June	8.	To Cash, Covers	60	
June	10.	To Cash, Binders	1 50	
June	10.	To Cash, Covers	2 70	

Cr.

Jan.	7.	By Cash, Money orders	Voucher No. 432.		144 05
Jan.	31.	By Cash, Minneapolis Post Office	" 433.		28 05
Feb.	26.	By Cash, Gurth	" 434.		8 00
Mar.	4.	By Cash, Barret & Co	" 435.		13 13
Mar.	—.	By Cash, Barret & Co	" 445.		15 89
		To Balance to Current Expense		201 29	
				$209 12	$209 12

STUDENTS' FEES.

Dr.

1878.				
Jan.	—,	To Cash	$ 85 00	
July	—,	To Cash	35 00	
Sept.	30,	To Cash	1,200 00	
Oct.	18,	To Cash	100 00	
Nov.	30,	To Cash	250 00	
		By Transfer from Incidentals		$700 35
		By Balance, Current Expense		969 65
			$1,670 00	$1,670 00

GEOLOGICAL SURVEY.

Dr.

1878.			
April	5,	To Cash	$1,000 00
June	26,	To Cash	1,000 00

Cr.

		By Balance from last statement		$5,522 04
		By Transfer Museum from Current Expense		603 03
1877.				
Dec.	24,	By Cash, Winchell	Voucher No. 10.	200 00
Dec.	31,	By Cash, Juni	" 21.	7 50
Dec.	31,	By Cash, Balance Account Current	" 26.	14 18
1878.				
Jan.	28,	By Cash, Expense Account	" 44.	31 35
Jan.	31,	By Cash, Winchell	" 54.	200 00
Feb.	2,	By Cash, Juni	" 60.	9 37
Feb.	5,	By Cash, Herrick	" 63.	9 60
Feb.	28,	By Cash, Winchell	" 78.	200 00
March	31,	By Cash, Winchell	" 98.	200 00
April	10,	By Cash, Benjamin	" 118.	37 25
April	10,	By Cash, Benjamin	" 119.	31 30
May	30,	By Cash, Winchell	" 134.	200 00
May	31,	By Cash, Winchell	" 156.	200 00
May	9,	By Cash, Expense Account	" 162.	100 00
June	13,	By Cash, Winchell	" 209.	200 00
June	15,	By Cash, Analyses	" 212.	40 00
May	27,	By Cash, Greeley	" 218.	2 25
May	30,	By Cash, Whitman	" 221.	100 00
June	3,	By Cash, Hall	" 225.	75 00
June	4,	By Cash, Blankets	" 228.	10 00
June	4,	By Cash, Field Expenses	" 229.	50 00
June	8,	By Cash, Tents	" 234.	31 00
June	22,	By Cash, Field Expenses	" 243.	10 00
		By Cash, Boat	" 246.	70 00
		By Cash, Field Expenses	" 250.	34 46
		By Cash, Blankets	" 251.	10 00
July	3,	By Cash, Janney Bros	" 256.	18 40
July	6,	By Cash, Lathe and Apparatus	" 261.	145 00
July	11,	By Cash, Green	" 272.	42 75
July	26,	By Cash, Expense Account	" 273.	100 00
July	30,	By Cash, Smith	" 274.	9 00
Aug.	23,	By Cash, Juni	" 284.	78 25
Aug.	20,	By Cash, Hall	" 282.	100 00
Sept.	3,	By Cash, Malman	" 291.	127 34
Sept.	3,	By Cash, McLennan & Co	" 292.	14 69
Sept.	10,	By Cash, Bowman	" 294.	90 00

Aug.	24,	By Cash, McLennan & Co	Voucher No. 297.		14 89
Aug.	26,	By Cash, Blankets	" 299.		5 00
Aug.	27,	By Cash, Snow	" 300.		94 00
Aug.	29,	By Cash, Winchell	" 302.		200 00
Aug.	29,	By Cash, Hill	" 303.		21 00
Sept.	30,	By Cash, Wilson	" 321.		32 49
Sept.	30,	By Cash, Wilson	" 322.		2 44
Aug.	8,	By Cash, Wiland	" 365.		8 87
Oct.	3,	By Cash, Winchell	" 367.		200 00
Oct.	14,	By Cash, Pott, Young & Co	" 379.		246 83
Sept.	—,	By Cash, Mayhew	" 391.		20 48
Sept.	26,	By Cash, Mayhew	" 392.		21 43
Sept.	28,	By Cash, Cariboo	" 393.		10 00
Oct.	—,	By Cash, Hall	" 394.		6 30
Oct.	—,	By Cash, Mayhew	" 395.		10 97
Oct.	26,	By Cash, Mayhew,	" 396.		10 17
Oct.	30,	By Cash, Morrison	" 397.		40 37
Oct.	30,	By Cash, Lightbody	" 398.		112 84
Nov.	—,	By Cash, Hall	" 400.		57 60
Nov.	2,	By Cash, Winchell	" 403.		200 60
Nov.	4,	By Cash, Hall	" 405.		100 00
Nov.	30,	By Cash, Winchell	" 420.		200 00
Nov.	30,	By Cash, Hall	" 421.		100 00
Nov.	19,	By Cash, Hall	" 427.		200 00
Dec.	7,	By Cash, Malman	" 431.		114 00
March	25,	By Cash, Analyses	" 109.		90 00
May	31,	By Cash, Advertising	" 458.		9 80
Aug.	31,	By Cash, Supplies	" 439.		14 58
Aug.	31,	By Cash, Incidentals	" 459.		36 68
Aug.	31,	By Cash, Incidentals	" 460.		6 17
Aug.	31,	By Cash, Freight	" 461.		32 98
Aug.	31,	By Cash, Apparatus	" 462.		137 45
Aug.	31,	By Cash, Supplies	" 463.		102 11
Sept.	30,	By Cash, Transportation	" 464.		85 00
April	15,	By Cash, Field Expenses	" 466.		60 00
Oct.	30,	By Cash, Field Expenses	" 467.		50 00
Nov.	26,	By Cash, Field Expenses	" 468.		75 00
		By Balance, Museum			420 94
		To Balance		$10,069 15	
				$12,069 15	$12,069 15

MUSEUM ACCOUNT.

1878.					
Jan.	31,	By Cash, Paul	Voucher No. 56.		$124 50
Feb.	20,	By Cash, Minerals	" 71.		105 00
March	7,	By Cash, Herrick	" 90.		4 05
April	1,	By Cash, Juni	" 105.		4 50
April	1,	By Cash, Juni	" 106.		6 45
April	16,	By Cash, Herrick	" 127.		4 00
May	11,	By Cash, Syffert	" 164.		16 50
April	29,	By Cash, Syffert	" 189.		10 50
May	25,	By Cash, Syffert	" 217.		17 25
May	29,	By Cash, Syffert	" 219.		4 20
June	12,	By Cash, Gardiner	" 240.		12 78
Aug.	23,	By Cash, Herrick	" 283.		97 20
May	19,	By Cash, Sundries	" 290.		13 41
		To Balance to Geological Survey		420 94	
				$420 94	$420 94

BUILDING ACCOUNT.

DR.

		To Balance from last Statement	$7,457 09	

CR.

1878.				
Aug.	23,	By Cash, Wheaton & Reynolds........Voucher No. 285.		$1,165 99
		By Balance		6,291 10
			$7,457 09	$7,457 09

HEATING AND FURNISHING.

DR.

		To Balance from last Statement	$245 86	

CR.

1877.				
Dec.	22,	By Cash, Museum..........Voucher No. 5.		$25 00
1878.				
Mar.	2,	By Cash, Museum.......... " 87.		25 90
April	13,	By Cash, Bennet.......... " 121.		65 55
		By Balance		129 41
			$245 86	$245 86

EXPERIMENTAL FARM FUND.

DR.

		To Balance from last Statement	$671 87	

LAND SALES' FUND.

DR.

		To Balance from last Statement	$813 42	

SALT LAND SALES.

CR.

Oct.	4,	By Cash, Wright..........Voucher No. 370.		48 00

Dr.

Oct.	30,	To Cash, Sale of Land	$2,941 64	
		By Balance		2,893 64
			$2,941 64	$2,941 64

SUMMARY OF ACCOUNTS.

Building Account, to Balance		$6,291 10
Heating and Furnishing, to Balance		129 41
Experimental Farm Fund, to Balance		671 87
Land Sale Fund, to Balance		813 42
Salt Land Sales, to Balance		2,893 64
Current Expense, to Balance		294 28
Geological Survey, by Balance	$10,069 15	
Balance on Hand	1,024 57	
	$11,093 72	$11,093 72

TWELFTH ANNUAL REPORT

OF THE

PRESIDENT

OF THE

UNIVERSITY OF MINNESOTA

TO THE

BOARD OF REGENTS.

1877-8.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.
DECEMBER 31, 1878.

SIR: I have the honor herewith to transmit the twelfth annual report of the condition and progress of the University.

I have the honor to be,
Very respectfully,
Your obedient servant,
WILLIAM W. FOLWELL,
President.

To the Hon. HENRY H. SIBLEY,
President of the Board of Regents.

REPORT OF THE

PRESIDENT OF THE UNIVERSITY.

To the Honorable the Board of Regents:

The University year 1877–8 began on the 11th day of September, 1877, and ended June 6th, 1878. The dates of the recesses and legal holidays may be seen in the annual calendar for the year.

PERSONS AND DUTIES.

ATTENDANCE.

The following tables exhibit the enrollment and classification of students for the year:

SUMMARY—1877–78.

COLLEGE OR DEPARTMENT.	CLASS.	Gentlemen.	Ladies.	Totals.
Science, Literature and the Arts	Senior	11	3	14
	Junior	16	8	24
	Special	1	....	1—39
Mechanic Arts	Senior	1	....	1
	Junior	2	....	2—3
Agriculture	Special	1	....	1—1
Collegiate Department	First	15	12	27
	Second	35	11	46—73
	Third	48	29	77
	Fourth	63	47	110—187
	Special	42	26	68—68
Totals		235	136	371

OR BY CLASSES ONLY.

Seniors—of all Departments	15	
Juniors—of all Departments	26	
Sophomores—First Class, Collegiate Department	27	
Freshmen—Second Class, Collegiate Department	46—	114
Preparatory, Third Class, Collegiate Department	77	
Preparatory, Fourth Class, Collegiate Department	110—	187
Special	70—	70
Total		371

COLLEGE OF SCIENCE, LITERATURE AND THE ARTS.

CLASS.	COURSE.	Gentlemen.	Ladies.	Total.
SENIOR	Classical	5		5
	Scientific	5	2	7
	Modern	1	1	2—14
JUNIOR	Classical	7	1	8
	Scientific	6	4	10
	Modern	2	3	5
	Speciall	2		2—25
Totals		28	11	39

COLLEGE OF MECHANIC ARTS.

CLASS.	COURSE.	Gentlemen.	Ladies.	Total.
SENIOR	Mech. Engineering	1		1
JUNIOR	Civil Engineering	1		1
	Mech. Engineering	1		1
Totals		3		3

COLLEGE OF AGRICULTURE.

SPECIAL STUDENTS—Gentlemen .... 1.

COLLEGIATE DEPARTMENT.

	COURSE.	Gentlemen.	Ladies.	Total.
...	Classical	5	2	7
	Scientific	9	4	13
	Modern	1	6	7
		15	12	27
..	Classical	18	1	19
	Scientific	12	3	15
	Modern	5	7	12
		35	11	46
..	Classical	13	1	14
	Scientific	24	3	27
	Modern	11	25	36
		48	29	77
..	Classical	13	4	17
	Scientific	49	12	61
	Modern	1	31	32
		63	47	110
...	....	42	26	68
...	....	203	125	328

ADMISSIONS.

1877 the experiment of holding examinations
ious parts of the state, which had long before
hich had received the sanction of the board of
t in practice.
enrollment and examination of an unprece-
er of candidates. This was partly due to the
declaration of intention to enter the Univer-
t any persons, without restriction, were allowed
ersons were enrolled in Dodge Center, St. Cloud,
y, New Ulm, Owatonna, Champlin, Rochester,
ır and Redwood; 81 were enrolled in Minne-
23 at and after the opening of the scholastic

year. Total of examinees, 330. Of this total, 12 on learning the nature of the examinations withdrew, and 95 submitted to partial examination only. Accordingly 223 persons were fully examined. From this number subtract 43 who failed, and there remain 180 successful candidates. 130 of these joined the classes in September or later. In the course of the year 34 persons from the number of candidates whose examinations were at first incomplete or unsuccessful, were admitted, and three were admitted without examination, by vote of the general faculty.

The whole number of new students admitted to instruction in the year 1877–8 was, as above, one hundred and sixty-seven (167.) They selected their courses of study as follows:

Classical Course	Gentlemen	16	
	Ladies	4	20
Scientific Course	Gentlemen	55	
	Ladies	17	72
Modern Course	Gentlemen	4	
	Ladies	37	41
Selected Studies	Gentlemen	20	
	Ladies	14	34
	Total		167

The average per cents of merits for the *elementary* branches, in which all applicants are by rule examined, were as follows:

Reading, 76; Writing, 72; Spelling, 73; English Grammar, 59; Arithmetic, 73; Elementary Algebra, 72; Geography, 77; United States History, 68; Average, 72.

In the report for the year to the State Superintendent of public instruction, may be found a particular account of the manner in which the "local examinations" for admission, were conducted during the summer of 1878, by committees of the General Faculty, acting under their regulations.

GRADUATIONS.

The sixth Annual Commencement was held in the Assembly hall of the University, on June 6th, 1878. The exercises were conducted according to the following programme.

The University of Minnesota, Sixth Annual Commencement, June 6th, 1878.

ORDER.

Music—Overture "Invocation A Ste. Cecille," *Lamotte.*
Prayer—By the Rev. Henry Cross, D. D. of St. Paul.
Music—Romance "Youth's Prayer," *Thiele.*
tio Salutatoria*....Miss Robinson.
tion—The Town Meeting....Mr. Bryant.
tion—The Mechanical Engineer....Mr. Bushnell.
tion—Man the "Roof and Crown of Things"....Mr. Couillard.
Music—March from Tannhaeuser, *Wagner.*
tion—An International Code....Mr. Howell.
tion—Liberty and Philosophy....Mr. Lewis.
ay—The Golden Age....Miss Maes
tion—Public Opinion....Mr. Newton.
Music—Selection "Girofle Girofla" *Lecocq.*
tion—Music in Civilization....Mr. Prichard.
tion—Has every Man his Price?....Mr. Smith.
tion—Communism....Mr. Taylor.
tion—Social Science and Legislation....Mr. Warren.
Music—Fantasia for Violin, *Weissenborn.*
tion—Skilled Labor....Mr. Williams.
tion—No Caste in Education....Mr. Wood.
ay—Foundation Stones—Valedictory*....Miss Getchell.
Music—Overture "Stradella," *Flotow.*
Conferring of Degrees.
Music—Kutschke Polka, *Stasny.*
Benediction.

By election of the class.

The degrees conferred were as follows:

COLLEGE OF SCIENCE, LITERATURE AND THE ARTS.

Bachelors of Arts.

lian Clarence Bryant....St. Peter.
hn Hamilton Lewis....Monticello.
os. Rogers Newton....Maple Grove.
n Roland Prichard....Judson.
niel Williams....Lime Springs, Iowa.

Bachelors of Science.

d. Leslie Couillard....Richfield.
ttie Getchell....Minneapolis.
lson Torrey Howell....Chatfield.
ry Warwick Robinson....Minneapolis.

Harvey Jay Smith.......................................Red Wing.
Myron De Vere Taylor.................................Melrose.
William John Warren..................................Medford.
Henry Clay Leonard, (B. C. E., 1875)....................Washington.

Bachelors of Literature.

Mary Ann Maes..Owatonna.
George Albert Wood....................................Elliota.

COLLEGE OF MECHANIC ARTS.

Bachelor of Mechanical Engineering.

Charles Spencer Bushnell...............................Minneapolis.

A brief address delivered to the candidates, is offered to be print with this report.

THE WORK OF THE YEAR.

The first term of the year began September 11th, and ended D cemcer 6th, 1877; the second term extended from December 1 1877, to March 6th 1878, and the third from March 12th, to Ju 6th, 1878. The whole number of working days was 181. T following table exhibits the work, as to kind and amount perform in the several departments of instruction as reported by the respe tive officers in charge. In addition to the information given previous tables, this notes the text books used, or specifies lectu when the instruction was so given. The inspection of exami tion and many other papers could not be included in such exhibit.

	Text Book.	Instructor.	No. of Exercis's	Class.	No. of Students	Class.
d.						
..	Olney.	Thompson.	30	Second.	58	II.
..	Peck.	"	20	First.	11	II.
..	Snell.	"	30	"	25	III.
..	Olney.	"	50	Junior.	16	I.
..	Loomis.	"	40	Senior.	8	I.
..	Olney.	"	50	Junior.	6	II.
..	Todhunter.	"	46	"	7	III.
..	Ficklin.	"	30	Fourth.	26	III.
..	Barker.	Peckham.	40	Second.	63	I.
..	Lectures.	"	14	"	63	I.
..	(Manuals of Appleton, Fresenius and Odling.)	"	50	Senior.	2	I.
..		"	50	Jun&Sen	6	I.
..		"	50	Junior.	2	I.
..		"	50	Junior.	3	I.
..		"	35	First.	14	II.
..		"	54	Senior.	1	II.
..		"	54	Junior.	1	II.
..		"	54	Junior.	2	II.
..		"	54	Junior.	5	II.
..		"	22	First.	12	III.
..		"	53	Special.	1	III.
..		"	53	Junior.	1	III.
..		"	53	Junior.	2	III.
..		"	53	Junior.	1	III.
..		"	53	Junior.	1	III.
..	Lectures.	"	38	Second.	15	III.
..	Recitations.	"	16	"	15	III.
..	Lectures.	"	11	Senior.	14	II.
..	Peck's Ganot	Peck.	54	Fourth.	69	I.
..	Snell's Olmsted.	"	54	First.	11	I.
..	Ganot.	"	54	Third.	37	II.
..	(Laborat'ry)	"	57 d. h.	Senior.	1	II.
..	Ganot.	"	57	Second.	20	III.
..	"	"	57	"	25	III.
.)	Dana.	Winchell.	108	Third.	93	II.
..	Lectures.	"	20	Junior.	11	III.
..	"	Hall.	32	Junior.	11	III.
is	Gray.	Leonard.	112	Third.	57	III.
..	Dalton.	Lacy.	8	Fourth.	60	III.
..	"	Leonard.	46	"	60	III.
..	Goodrich.	Marston.	55	Senior.	6	I.
..	Lectures.	"	55	"	13	III.
..	Brooke & Lectures.	"	55	Junior.	24	II.
..	Carpenter.	"	55	First.	5	I.
..	Morris&Sk't.	"	55	"	8	II.
..	Carpenter.	"	57	"	2	III.
..	Hepburn.	"	55	"	30	II.
..	Jevons.	Folwell.	55	"	28	I.
ec)	Gilmore.	Mrs Smith.	162	Fourth.	116	I.
..	Swinton.	"	108	"	71	II.
r.)	Freeman.	Miss M. J. C.	110	"	59	I.

..	Instructor.	Exercis's	Class.	No. of Students	Term.
	Clarke.	51	First.	9	I.
	"	27	"	9	"
gh	"	108	Third.	53	"
	"	53	"	53	"
gh	Hutchinson.	54	Fourth.	29	"
	Clarke.	55	"	44	"
	Brooks.	54	Junior.	11	II.
	Clarke.	52	Second.	16	"
	"	16	"	16	"
	"	52	"	19	"
	"	19	"	19	"
	"	52	Third.	23	"
	"	23	"	23	"
	"	52	"	28	"
	"	28	"	28	"
gb	Hutchinson.	52	Fourth.	26	"
	Miss M. J. C.	50	"	46	"
	Brooks.	20	Senior.	8	III.
a,	"	48	Junior.	12	"
	"	24	"	12	"
	Clarke.	52	First.	9	"
	"	9	"	9	"
	"	52	Second.	13	"
	"	26	"	13	"
	"	52	"	23	"
	"	46	"	23	"
	"	55	Third.	21	"
	"	42	"	21	"
	Miss M. J. C.	56	"	21	"
gl	Hutchinson.	110	Fourth.	49	"
	"	49	"	49	"
	Brooks.	24	Senior.	5	I.
&					
	"	24	"	5	"
	"	53	Junior.	8	"
	"	24	"	8	"
	Hutchinson	52	Second.	20	"
	"	60	"	20	"
	"	54	Third.	8	"
	"	8	"	8	"
	"	54	Fourth.	18	"
	Brooks.	51	Senior.	5	II.
	"	49	First.	5	"
	Hutchinson.	52	Second.	16	"
	"	52	Third.	8	"
&					
	"	52	Fourth.	18	"
	Brooks.	51	First.	7	III.
	"	18	"	7	"
	Hutchinson.	52	Second.	19	"
	"	57	"	19	"
&					
	"	55	Fourth.	17	"

[illegible]	Campbell	[illegible]	Junior.	[illegible]	III.
[illegible]		[illegible]	Senior.	[illegible]	I.
		[illegible]	"	[illegible]	I.
[illegible]	Campbell	[illegible]	Second.	[illegible]	II.
[illegible]		[illegible]	Junior.	[illegible]	II.
[illegible]		[illegible]	"	[illegible]	III.
[illegible]		[illegible]	"	[illegible]	II.
		[illegible]	"	[illegible]	III.
[illegible]	Campbell	[illegible]	Junior.	[illegible]	I.
[illegible]	Campbell	[illegible]	Senior.	[illegible]	III.
[illegible]	[illegible]	3 d. h.	Junior.	[illegible]	II.
[illegible]	[illegible]	[illegible]	First.	[illegible]	III.
	[illegible]	47	"	[illegible]	[illegible]
[illegible]	[illegible]	54	Fourth.	[illegible]	II.
[illegible]	Rhame	54 d. h.	Third.	[illegible]	I.
		54	Second.	[illegible]	II.
		54	First.	[illegible]	II.
		[illegible]	Fourth.	[illegible]	III.
[illegible]	Rhame	54	Jun.&Sen.	[illegible]	I.
[illegible]		54	Senior.	[illegible]	I.
[illegible]	Peck	54	Jun.&Sen.	[illegible]	I.
[illegible]		54	Junior.	[illegible]	[illegible]
[illegible]		54	Senior.	[illegible]	[illegible]
[illegible]		[illegible]	Junior.	[illegible]	[illegible]
[illegible]		[illegible]	Senior.	[illegible]	[illegible]
[illegible]		20	"	[illegible]	[illegible]
Lectures		4 d. h.	Second.	[illegible]	[illegible]
Field Work		18 "	"	[illegible]	[illegible]
[illegible]	Folwell	[illegible]	Senior.	[illegible]	[illegible]
[illegible]		[illegible]	"	[illegible]	[illegible]
[illegible]		3	"	[illegible]	[illegible]
Papers		[illegible]	"	[illegible]	[illegible]
Lectures		47	"	[illegible]	[illegible]
Lectures	Hewitt	[illegible]	"	[illegible]	[illegible]
[illegible]	Laing.	34	Junior.	[illegible]	[illegible]
[illegible]		46	Second.	[illegible]	
[illegible]		[illegible]	First.	[illegible]	
Swinton		56	Fourth.	[illegible]	
	Mrs. Smith	116	"	[illegible]	

Subject.	Text Book.	Instructor.	Exercis's	Class.	No. of Students	Term.
MILITARY SCIENCE.						
Co. Drill (Duties of Officers)	Upton.	Lundeen.	16	First.	12	I.
" (Duties of Guides.)	"	"	16	Second.	40	I.
"	"	"	16	Third.	43	I.
Squad Drill and Manual of Arms....................	"	"	20	Fourth.	46	I.
Military Organization	Lectures.	"	2	1st & 2nd	50	I.
Co. and Battallion Drill—(Duties of Officers).......	Upton.	"	38	First.	6	III.
Co. and Battallion Drill....	"	"	38	2d, 3d, 4th	109	III.
Skirmish Drill.............	"	"	5	1st, 2nd, 3d, 4th.	101	II.
Target Practice............	....	"	4	"	64	III.

This Commencement was honored by the presence of the Senate of the State in a body, who adjourned for that purpose.

The dinner of the alumni and their guests, including the officers of the University. many State officers and legislators, at the Nicollet House, deserves mention, as a most agreeable re-union, calculated to stimulate and refresh the loyalty of those who have been recipients of your care and instruction in former years. It seems to me in every way proper that the University should cherish this feeling of respect and affection, by granting some pecuniary assistance to the management of these meetings. A regular appropriation of a small amount would ensure their success, and I am certain no suspicion of wrong use of public money could rest upon the Board. The commencements of a college is everywhere recognized as an indispensable feature of college life. They cannot be conducted, even on a small scale, without a considerable expense, and as this University grows in number and importance the expenditures for Commencement Day will increase. It is therefore proper that these charges be included in your estimate of expenses, and provided for by a regular appropriation. For the first time, this year, we failed to enjoy the music of the fine military band of the 20th U. S. Infantry, for many years stationed at Fort Snelling, the headquarters of the Brevet Maj. Gen. Sykes. The performance of the Great Western Band was of a very high character, heightening the interest of the day.

The following table shows the number and kinds of degrees which have been conferred by the University.

	1873.	1874.	1875.	1876.	1877.	1878.	Total.
Bachelor of Arts............	2	1	3	4	9	5	24
Bachelor of Science.........	......	1	2	5	3	8	19
Bachelor of Literature......	......	......	1	......	3	2	6
Bachelor of Civil Eng.... ...	......	......	3	3	......	......	6
Bachelor of Mech. Eng......	......	......	......	......	......	1	1
Bachelor of Architecture....	......	......	......	......	1	......	1
Bachelor of Agriculture......	......	......	... ..	......	......	......	......
Total....	2	2	9	12	16	16	57

This table likewise exhibits the selections of degrees and courses of study leading to each, made by candidates. So far the traditional classical course seems to be most frequently chosen. The probability is, that for a long time to come as large a number of persons proportionally to the population will continue to demand this ancient and honorable curriculum, while large additional numbers will desire one or other of the new courses. Were our colleges and universities to refuse to conduct the scientific and literary or modern language courses these persons would be denied the higher education so far as schools are concerned.

The technical courses in engineering and agriculture do not now attract large numbers anywhere, because the country does not yet insist on scientific and scholarly qualifications in the directors of industry and the liberal training formerly demanded of candidates for professions seems to have fallen into disrepute with the majority of persons entering them. The ministry remains the only learned profession.

MASTERS' DEGREES.

In pursuance of the by-laws adopted at the last annual meeting of the Board, the faculties of the Colleges of Science, Literature and the Arts, and of Mechanic Arts, have established the regulations necessary to carry them into effect. It was not deemed practicable to offer to candidates any regular, stated instruction at the University, as the professors are now employed with undergraduate teaching. The plan adopted simply maps out certain fields of study and investigation, suitable to the particular degrees aspired to.

The cultivation of certain portions is insisted on in each case as pre-requisite to graduation, but a wide range of elective work remains open. In each case a thesis appropriate to the nature of the degree is required to be submitted.

In the College of Science, Literature and the Arts, several candidates have already been enrolled.

For the full text of the regulations adopted reference is made to the annual calender for 1877-8. Other rules, in particular. for fixing the manner and extent of the examinations, will at length become necessary. It is believed that this University was the first institution of the North to announce the policy, since adopted in many quarters, of granting no degrees, except for merit as determined by examinations. This policy was agreed to by this Board as early as June, 1870.

I. *EQUIPMENT.*

BUILDINGS.

An inspection of the buildings will show them to be in good repair and preservation; a fact creditable to the large body of students who have gone in and out during the year. One dollar will cover all the wilful damages of the year. The serious damage to the plastering of the assembly hall by the defects of the slate roof has ceased since the completion of the new tin roof put on the last summer. As this otherwise fine room is thus much defaced, it is important that the original plan for its decoration be soon carried out.

There is still a lack both of sufficient and suitable furniture for many of the rooms, in particular the ladies' parlor and the faculty rooms. The common cottage chairs and old school desks still in use in several class rooms, should be replaced by the tablet chairs provided for others.

The needs of the institution in the way of new structures will be referred to later.

MUSEUM AND COLLECTIONS.

The Curator's report will show in detail the additions and enlargements to the General Museum. The opening of the south room for the display of minerals, has been the principal change.

Considerable accessions have been made to the collections of Agriculture and Technology, but they cannot be displayed without additional cases. At the date of this report, the articles ordered under the small appropriation of the board for the increase of the Classical Museum have not been received, so that no changes are to be noted.

APPARATUS.

The Chemical Laboratory has received some additions to its outfit, through the necessity of providing assaying apparatus for the operations of the Geological Survey. It ought to be well known throughout the state, that this laboratory is now thoroughly equipped for all the ordinary analytical. metallurgicaland toxological examinations.

No material additions have been made either to the mineralogical or physical apparatus.

Attention is asked to the statement of the assistant professor in charge of physics, of the needs of that department. The point that physics is no longer a mere attachment to another department of instruction, but is in itself a vast and independent field, which must presently undergo subdivision. is, no doubt, well t---. A thor-oughly equipped and constantly growing museum of physics is already acknowledged to be indispen college or university. No other department of hum been extended so rapidly within the past thirty years, is now so widely developing. I would respectfu request for a moderate standing appropriation.

In the department of astronomy the equipmen stands where it has stood before, substantially at z fessor in charge has been seriously considering tl recommending to the Board, to discontinue the offe tion except the more elementary portions, on accou of the indispensable instruments. The kindly loan Minneapolis, of a fine telescope of sufficient power has been highly appreciated by the professor and hi

I must here be allowed to express my disappointn of the numerous representations in successive repor nications, of the need of a working observatory, ha a response from the legislature. The consequence the State University is indebted to the enterprise of for a standard of time by which to summon her c duties.

The department of History has been materially a lection of wall maps, imported by order of the E mittee at an expense of some seventy dollars. The also been reinforced by a number of tasteful ma colored by the professor himself.

There is pressing need in all departments of books, maps, and instruments.

THE PLANT HOUSE.

This establishment opened in a tentative manner the previous year by Professor Lacy has been in successful operation and has served a useful purpose in illustrating the instruction in Botany and Horticulture. Although no exertions have been made to reach a market, the sales of plants and flowers has been considerable, and it is believed that it would not be difficult by somewhat extending the house, to make the establishment self-supporting or nearly so. This however, might be at the expense of usefulness as an appliance of instruction.

EXPERIMENTAL FARM.

A considerable addition to the workable area has been made by the drainage of the hillside east of the barn.

The detailed report of Prof. Lacy, herewith transmitted, will show the nature and extent of the experiments and other operations carried on. A considerable amount of labor has been performed by students who have received customary wages of men or boys respectively. There are no means by which our young men can be compelled to labor on the farm at less wages than they can rèceive for similar services elsewhere. The resolution of the Board fixing their compensation at 12½ cents an hour is a dead letter and had better be repealed.

In connection with this topic the following question is submitted without discussion for the consideration of the Board:—

Unless the farmers of the state within a reasonable period, avail themselves of the instruction in scientific and practical agriculture to a far greater extent than hitherto, ought not the board in justice to the other branches of the institution to reduce the expenditures of the college of agriculture?

FRUIT FARM.

Of this there is only occasion to say here, that the report of Superintendent Gideon will be found with that of Professor Lacy, the fruit farm being made by law a portion or extention of the experimental farm.

While it is impossible to foresee the results of this new enterprise, this much is certain, that the landed investment is a good one for the University, and the reasonable promise of success under so able superintendence abundantly justifies the expenditure of the small amount appropriated from the State Treasury.

THE GEOLOGICAL AND NATURAL HISTORY SURVEY.

The sixth report of progress is herewith transmitted. A summary of the topics treated has already, through the kindness of the chief geologist been communicated for incorporation in the report of the Board, which renders unnecessary further remark in this place.

DRILL HALL AND GYMNASIUM.

There is none. Reference is respectfully made in the l--- ------ for a discussion of the needs and the promise of the m partment.

THE LIBRARY.

The whole number of volumes, exclusive of public d and pamphlets, added during the year was 716. Tl chiefly purchased out of the appropriations of the Bos previous annual meeting. I would respectfully recomn the appropriations for the purchase of books and periodical permanent and annual. When made from year to year it venient to close the accounts by reason of outstanding o considerable balances are lost to the library.

The attention of the Board is called to the list of forming appendix "B" of the last annual report. This bracing a very valuable collection of books, conforms clos best examples of the modern art of cataloguing, so f resources of the State printer would allow. The accessi the printing of this list have been so few that it is n necessary to encumber the report with their titles, and consent of the Board they will be held over to a later rep

So soon as possible a considerable appropriation shoul for binding periodicals and pamphlets, of which a large is now on hand.

DONATIONS.

The following donations have been duly acknowledged of the Board:

LIST OF DONATIONS.

Arthur M. Eastman:
    Eclectic Magazine, 1865.
W. E. Leonard, B. A.:
    Jackson's Optics.

Prof. E. J. Thompson:
De Imitatione Christi.

Regents of the University of the State of New York, through Hon. S. B. Woolworth, Secretary;
Annual Regents Reports 1865, 1872-76.
Annual Reports State Cabinet Natural History, 1868—1872.

Am. Unitarian Association:
Sermons by Jas. Walker.

War Department:
Ordnance Regulations.

Mrs. M. F. Pierce, Cambridge, Mass.:
Agassiz Contributions to Nat. History of U. S., 4 v.
Helvetius, Oeuvres completes.
Kant, Essays and Treatises, (trans.)
Cutter, War Poems.
"Tom Bowlings" Book of Knots.
Black's Guide to Warwickshire.

Prof. R. W. Laing, L. L. D.
Tale of a Tub, &c.
Calendar, London University, 1861-4.

H. W. Howgate, U. S. N.
Polar Colonization.

Dominion of Canada.
Geological Survey, Report of Progress, 1866-77.

U. S. Government.
Coast Survey, 1874.
Report, Chief of Ordnance.
Report of Survey of the Territories, Hayden.
Official Register, 1877.
Documents of, 44th Congress, 2nd Session.

PERIODICALS.

The following list comprises the periodicals and journals supplied to the reading room. Those marked with a * have been furnished gratuitously by the publishers, to whom the thanks of the Board are due:

Quarterlies—Journal of Speculative Philosophy, Edinburgh Review, Westminster Review, London Review, British Review, Popular Science Review, Mind, Bibliotheca Sacra, National Quarterly Review.

Bi-Monthlies—New Englander, N. A. Review, International Review.

Monthlies—Am. Journal of Science and Art, Appleton's Journal, Art Journal, Atlantic, Blackwood, Contemporary Review, Deutsche Revue, Eclectic, Harper's Monthly, Popular Science Monthly and Supplement, Scribner's Monthly, The Gardner's Monthly, Agriculturist, Live Stock Journal, Minnesota Farmer, Health Reformer, *Messenger of Peace.

Semi-Monthlies—Revue des Deux Mondes, Ueber Land und Meer.

Weeklies- Academy, Atheneum, Chemical News, Harper's Weekly, Littell's Living Age, London Times, Nature, Nation, Publisher's Weekly, *Official

Gazette of Patent Office, Library Journal, Scientific American and Supplement, *Anoka Sun and Republican, *Glencoe Register, *Prairie Farmer, Farmers' Union, Rural New Yorker, Country Gentleman, New Orleans Picayune, Alta California, *Owatonna Journal, *Minneapolis Freie Presse (Ger.) *Minneapolis Staats Tidning (Swedish), Richmond Whig, Boston Statesman.

Semi-Weekly—New York Tribune, *New York Evening Post.

Dailies—*War Department Weather Map, *St. Paul and Minneapolis Pioneer Press, *Minneapolis Tribune.

Books issued during the years named:

a few weeks before. The material results may be summ
the lands, buildings, and their equipment, forming succe

of this report. They are adequate for the instruction of four hundred students in most of the essentials of the traditional scholastic branches, and in some of those referred frequently to as comprising the new education. The immaterial, but most permanent results of these ten years' history, must be sought in the influences which may be exerted by nearly two thousand youths who have been here instructed. The number of persons whose circumstances have enabled them to persevere in a course of studies covering seven years, must not be taken as the only or the chief index of the work of a college. It may well be suspected, that if our American colleges were to enumerate among their alumni, all those who had been instructed but not graduated, many of the most useful and some of the most famous of their sons, would be found among the non-graduates.

The Board have reason to congratulate themselves and the State upon the progress which has been made. The past, therefore, is secure. When the present outfit is compared, not with what will be indispensable in the distant future, but with what the leading American colleges to-day are providing, no governing board nor legislature can be credited with full performance of duty, which merely contents itself with a careful expenditure of the present income. If merely to audit receipts and disbursements were all, a committee of state officers would be sufficient.

The great and chief office of a governing board is to provide for, i. e., to foresee the future and its demands, to plan, to aggregate and to amplify the means and facilities of the University. Especially is this true in a new state. The time is passing, and will so on be passed forever, when it may be possible to provide, without inconvenience or distress, for such an endowment for this institution as shall not only ensure its development as a leading centre of learning in the nation, but shall relieve future generations of any serious burden of taxation for its support. The lands now set apart for the endowment will yield, with a continuance of good management, a round million dollars after, say, twenty years. The maximum income cannot be placed above five per cent., at which rate the yearly receipt would be $50,000. In twenty years from this time the annual expenditures of this University ought not to be less than $150,000. It will then be merely one-third of the present annual expenditure of Harvard University, and a trifle more than the whole outlay of the University of Michigan last year. The increase of the endowment, therefore, is a problem of the first importance for the Board of Regents, and will be until it is either solved or abandoned as impracticable. In the latter case the hope indulged by

some, that here in the center of the great northwest a great seat of learning may in our time be founded for all generations, must be deferred until individuals more generous than states shall devote the needful wealth.

It may, however, be suggested that the future may be left to care for itself, and that the duty of the present generation is done, when such opportunities for culture as may here be compassed, are placed before our youth. Descending to this ground, there still remains the most vexatious question, "how to increase the present current income in view of impending demands?"

The plan and outfit of the University is respectable for this year, but will not be in three or five years. If no new departments, such as law and medicine shall be attempted, those now in operation will need large additional outlays to meet the growing demands. There must be more class rooms, more laboratory and museum room, more, a great deal more space for the library; there must be a gymnasium. Books, instruments, furniture and apparatus of all kinds, in large amounts, will be needed. In these days, when scholarship runs into specialties, and can only be maintained by special studies, it is not possible to secure the best instruction from men of mere general information. The previous reports have already specified particular additions which ought even to-day to be made to the teaching force.

It is not, therefore, the future alone, but the present needs of the University which calls for all the energy and wisdom of the Board.

The University can not remain stationary and remain respectable. Her offer of free instruction will be disregarded by the youth of Minnesota, if there is reason for them to believe it to be scant or inferior.

Permit me, speaking with the earnestness of one in daily contemplation of the present demands and future possibilities of this University, to express the conviction, that no trivial considerations, whether of reserve or despair, should prevent this Board from demanding of the representatives of the people those means by which alone your trust can be executed.

APPENDIX A.

Short Address by President Folwell, Upon Conferring the Degrees a the Sixth Annual Commencement, June 6, 1878.

Mr. President:

Before proceeding to the ancient and simple ceremony which will mark the close of the under graduate career of these candidates, permit me to use the customary privilege of speaking some words to them. I desire to certify you that the degrees about to be conferred by your authority belong by right to those who receive them, because they have severally complied with the conditions prescribed by the Board of Regents acting in pursuance of law. These diplomas are not complimentary certificates to a certain term of residence here, but to the successful prosecution and completion of long and exacting courses of study. Had these courses been by you made shorter or easier, or had the faculty been less faithful in exacting thorough performance, the number of candidates appearing here to-day to receive your decoration might have been much greater. I beg you to remember that these successive graduating classes are the few heroic survivors of many scholastic campaigns. The thining-out process, however, I cannot claim to be due to an excessive rigor in our own discipline. It is the prevailing rule of American Colleges, including the oldest of them, that less than 50 per cent. of those who enter, ever reach graduation. Nor need this seem strange when we take into account financial complications, family changes, disease, to say nothing of the casualties of the examination room.

We present these candidates then as our Spartan band, and I think the fact that they are here to-day performing the final duty imposed by you is proof enough that they have been faithful and dutiful and are worthy to be honored by you.

My friends you have now gone through college, you have "got an education." You will be congratulated on all hands and you

will be sensible of an honest pride in having at length obtained so good a degree. Your friends will call you fortunate—and fortunate indeed you are, but it may be for reasons other than those which find affectionate expression from the lips of happy friends. I doubt whether any of you will be happier, as the world uses the word, than other people. The perfect physical poise and integrity of the seaman or the mountaineer you will never know; the untroubled serenity and the undoubting omniscience of the well fed ignoramus is not for you. You have passed many years learning how little men really know and how easily they are led and misled. You have had occasion to note how hard a struggle man wages on this planet for his life and life's needs, against the whirlwind, the earthquake, famine, fire and flood, the wild beast, disease and bitterest and most fatal of all, the vices and ferocity of brother men. You have learned too much of the changes and chances of this mortal life ever to be happy, as children are happy. The ancient preacher said most truly: "For in much wisdom there is much grief, and he that increaseth knowledge increaseth sorrow."

It is not then on the score of happiness—for that is a dream—that I would congratulate you, but rather because by a course of scholastic discipline you have been permitted to furnish yourselves more completely for the duties of life, and to perform higher and nobler service than the unskillful, in the good cause of God and country.

It is especially appropriate and to be expected, that the alumni of a public endowed university, offering free instruction, should devote themselves to the public service and to social actions.

That you appreciate this obligation, the deep interest you have taken in those studies which lie nearest to the practical public questions, testifies. The general turn of the discussions which you have brought forward here to-day, betrays your sense of interest and responsibility in regard to many of the problems of legislation and society which are ever occurring and recurring in free States. What some of these problems are and how grave and menacing they just now are looming into our sky, some of you have sufficiently shown. Our Arcadian era—our golden age—with its simple ways and pure democracy, is gone. A great nation, spanning the continent, lately reinforced by many millions of persons untrained in the art of self-government and these clustering into a few great cities, can no longer govern itself by the simple republican routine of the town meeting. Every thinking man is wrestling with the problem, how shall we preserve order without imperilling libe[rty]
I commend your resolution and industry in grappling w[ith]

questions, even in the arena of the drill ground, and I trust you will not be discouraged hereafter by any of those circumstances which surround public life.

Politicians in the just and noble sense of the word I hope you all will be, politicians in the low and bad sense never.

I do not, however, advise you or any of you to enter the political arena, to figure as combatants in the lot struggles of caucus and party. You, as thinkers, can do far better service on the private benches. The candidate for office is not favorably situated to form just and clear opinions of public policy. The office holder must follow forms and precedents, and administer the law as he finds it. In a country such as ours the active politician cannot govern himsself by abstract and speculative considerations. He must be looking constantly into the glass of public sentiment to see what signals it reflects. Be it yours to form, or help to form that public opinion, according to principles. You will, as good citizens faithfully discharge any public duties which your fellow citizens may impose upon you, but you will never covet offices. The conduct of puclic affairs demands abilities, mental, moral and physical in such combinations as few men possess. The probability is that the thinker and scholar will not possess them. If so, let him not complain that he has no weight in the state. Need the pale mathematician, who maps out sea charts and navigation tables complain that he is worth no more than a child on the quarter deck of man-of-war or steamer, off a dangerous coast in a tempest? No, no, such men as De Tocquiville and Guizot, Locke and Bentham, Lieber and Woolsey—the men who make the charts by which statesmen must steer the ship of State, need have no fears for their usefulness or their fame.

In exhorting you, therefore, to the serene but earnest study of social questions, I would not have you think that such questions furnish their own solution. Your political philosophy will be but a part of your general philosophy of life and conduct. What has been said of theology and philosophy is just as true, perhaps, of politics and philosophy. "No difficulty emerges in theology (politics) which has not already emerged in philosophy." One of your number has well shown how great revolutions have been set going by the opinions invented or sanctioned by great thinkers. Be careful, then, what philosophy you lay down as the major premise of your logic of society and government.

In the conduct of your private lives let me add, that philosophy is of supreme importance. We are all philosophers at first or second hand. "As a man thinketh so is he," and so does he. If you

shall choose to think with some that there are no things existing for us except those which the bodily senses can take note of, you will, by and by, find yourselves teaching and practicing some epicurean manner of life, of which the outcomeis simply "eat, drink and be merry" as best you can.

You will, I trust, have adopted a better philosophy. whose logic will last you not to death, but to life; not to despair, but to hope; not to an endless sleep, but to immortal activity beyond the fading scenes of this world; remembering ever, that "the things which are seen are temporal, but the things which are not seen are eternal."

PROFESSOR LACY'S REPORT.

Wm. W. Folwell, President of the University of Minnesota:

SIR:—I respectfully beg leave to submit the following report of the College of Agriculture for the year ending Oct. 31st, 1878:

INSTRUCTION.

Three persons are now pursuing studies in the College of Agriculture. One is enrolled in the Elementary Course, one in a special course for the year 1878–9, and the third is a graduate of the University, pursuing the study of Agricultural Chemistry.

Special courses for the year 1878–9, including agricultural chemistry, natural philosophy, physical geography, physiology, farm drainage, farm accounts and agriculture, have been offered this year, as last, under the authority of the by-law admitting "any persons to any class in this college upon the sole condition that they appear to be competent to receive the instruction." These courses were published with the other announcements of the College of Agriculture in the University Calendar. Five hundred copies of this portion of the Calendar were bound separately and distributed to those who, it was supposed, might be specially interested. Five hundred circulars, letter size, calling attention to these special courses, have also been distributed by mail.

FARMER'S LECTURE COURSE.

Several inquiries have been made concerning the lecture course for farmers offered in the University Calendar, by persons who would like to attend the same. This lecture course is offered with the condition that thirty persons not members of any class in the University shall signify their intentions to attend it. It is believed that the value of such a course could be ascertained best by proceeding to give it without regard to promised attendance. Success should be measured, not by the attendance, but by the interest manifested in this institution and in agricultural education in the course of some period of time, say three or four years. To promote and secure this success two measures would be necessary:—(1.) Wide and liberal advertising in advance. (2.) The publication of the lectures and discussions in full in some one or more weekly papers, employing a stenographer whenever necessary to secure full and accurate reports. These two

measures are, it is believed, quite as important as to procure noted and expensive lecturers from abroad. Many of the Agricultural Colleges are now offering these lecture courses for farmers.

LIBRARY.

Thirty-five volumes of the "Journal of the Royal Agricultural Society of England" have been added to the list of agricultural works in the library, and constitute a most important and valuable addition. The "Country Gentleman" and "National Live Stock Journal" have been added to the list of agricultural papers received in the Reading Room.

MUSEUM.

One hundred and seventy-eight specimens of wood have been received from the United States Department of Agriculture. They were grown in Illinois, California, Oregon, Brazil and Argentine Republic. A series of the woods of our own State would be a most valuable addition. The case mentioned in last report has been filled with seeds, grains, grasses, models of machines, &c., and a large number of objects remain unprovided for. Additional cases are greatly needed.

ORCHARD, FRUIT GARDEN AND NURSERY.

Nothing in the orchard and fruit garden requires particular mention here. For purposes of experiment and instruction, ten to fifty each of the following trees and shrubs were procured and planted in the nursery last spring.

Mountain, White, Pitch, Scotch and Austrian Pines; Norway and White Spruces and Balsam Fir; American and Siberian Arbor Vitæs; Balsam and Silver Poplars; Cottonwood; Honey and Common Locusts; Sugar, Red and Silver-Leaved Maples; Bur, Swamp White, Black Scrub, Red, Black, Scarlet and White Oaks; Barberry; Wahoo; Virginia Creeper; Smoke Tree; Staghorn Sumac.

It is intended to make additions to this list from time to time. Silver-Leaved Maples to the number of 2,583 and 285 Box Elders, grown from the seed, were also transplanted.

VEGETABLE GARDEN.

Experiments with garden vegetables have been continued on substantially the same plan as heretofore, but observations have been taken more extensively and accurately.

These experiments include—

Bush Beans,	Pole Beans,	Garden Beets,
Carrots,	Parsnips,	Cucumbers,
Squashes.	Spinach,	Garden Peas,
Tomatoes,	Cauliflower,	Early Cabbage,
Late Cabbage.	Sweet Corn,	Pop Corn,
Lettuce,	Onions,	Swiss Chard.
Radishes.		

The results, as far as time has permitted us to prepare them, are detail the following pages:

GARDEN BEANS—DWARF.

Seventeen varieties were planted May 15th. Soil sandy, plowed the autumn previous, harrowed thoroughly before planting, and furrows then opened with a single shovel plow two and a half feet apart. The beans were dropped by hand in these furrows, five or six in a hill, and the hills eighteen inches apart, after which they were covered with the single shovel plow. Just before coming up they were harrowed with Thomas' smoothing harrow, and afterwards they were kept clear of weeds by running the cultivator between the rows, the hoe being used simply to cut the weeds from the row itself. The following table gives the results of the trial.

NAME.	Yield. *a*.	No. days from planting to first picking.
Refugee	Poor.	76
Intermediate Horticultural	Good. *b*.	69
Early Valentine	"	65
Early Round Yellowsix Weeks	"	61
Yellow Eye	Fair.	61
Dun Cranberry	Very Good. *c*.	69
Early Fejee	Good.	61
White Wax	Poor.	61
Black Wax	"	57
Golden Wax	"	57
Early Six Weeks	Fair.	57
Early Mohawk	Good.	57
Concord Bush	Poor.	67
Early China	Fair.	57
Early Rachel	Fair.	57
Newington Wonder	Best. *d*.	76
Broad Windsor	Poor.	....

a. Reported poor when less than 8 bushels per acre; fair when from 8 to 12; good from 12 to 16, and very good when over 16 bushels.

b. Rate of 14.6 bushels per acre.

c. Rate of 16.4 bushels per acre.

d. Rate of 23.5 bushels per acre.

In earliness the Wax varieties are not surpassed, while in tenderness, delicacy of flavor and length of season they are not equaled. In these respects they differ, however, among themselves. All things considered the Black Wax is doubtless the best. The Golden Wax has larger pods, and probably yields somewhat better, but it is not so long in season for snap beans, and is a little more affected by rust. The White Wax is decidedly delicate in the growth of the vine and inferior in yield.

The Intermediate Horticultural is similar to the old fashioned Cranberry, but on soils moderately rich does not run sufficiently to require poles.

The Newington Wonder, it will be observed, was very productive. Its qualities as a snap bean were not tested.

The Broad Windsor is a tall, coarse growing variety, of no special value the table, nor for any purpose, on moderately rich soils. On very rich soil might be profitable to grow for stock.

CAULIFLOWER.

Henderson's Early Snowball, Extra Early Dwarf Erfurt, Early Erfurt and E Paris were sown in hot bed April 1st, transplanted to another bed April 27 and to sandy soil in the garden May 23d. The first named, Henderson's E Snowball, proved far superior to all the others in earliness, and in number size of heads. None but good reports of it have been received. Extra E Dwarf Erfurt ranked second.

Carter's Dwarf Mammoth, Italian Early Giant, and Veitch's Autumn Gi were sown May 24th, and transplanted to sandy soil in the garden July 8th, no heads were obtained.

CARROTS.

Seed sown on sandy soil, in rows 30 inches apart, April 18th, 19th and 20 Plants thinned when large enough to about six inches in the row. The follo ing table shows the results of the experiment, the second column showing comparison the result of 1877 :

	Yield per acre, bush. of 60 lbs. each	
	1878.	1877.
Short Horn	210	124.7
Danvers	323	146.0
Early Very Short Horn	86	....
Improved Long Orange	293	50.9
Long Orange	154	52.2
Half Long Orange	232	....
Large Altringham	100	90.6
Large White Belgian	124	....
James' Intermediate	....	55.5
Half Long Carentan	....	35.9

PARSNIPS.

Seed sown on sandy soil, in rows 30 inches apart, April 18th. Plants thinned when large enough to about six inches in the row. The following table shows the results of the experiment:

	Yield per acre, bush. of 60 ℔ each.	Description of Roots.
Hollow Crowned	371	Long, slender, much branched—many small ones.
Sutton's Student	324	Long, slender, but little branched—many small ones.
*Long Sugar	369	Long, slender, more branched than second, less than first.
Maltese	388	Shorter. thicker, somewhat branched, but on the whole nice.
Round Early or Turnip	355	Turnip shaped, tolerably free from roots.

*Long Sugar was from Hollister, Carter & Co., the others from Gregory.

GARDEN PEAS.

Forty-seven varieties planted April 3d. Soil very sandy, plowed autumn previous and harrowed thoroughly before sowing. Furrows made with single shovel plow 2½ feet apart for medium and small, and three feet apart for large growing varieties. Seed sown in furrow with Planet Drill at rate of one quart to 235 feet, and covered 3 to 4 inches deep with single shovel plow. The cultivation consisted in harrowing thoroughly just before coming up, after which the cultivator was run between the rows. The hoe was used only to cut out weeds in the row. Many of the varieties have been on trial three and four years. The table gives in the first column the number of days from planting to first picking, 1878 and in the other columns the average of all the observations that have been made on "Yield," "Table Quality," length of "Picking Season" and "Growth of Vine."

Canada Victor. *r*.. 62
Hubbard's Curled Leaf. *d*....... ... . 62 "
Conqueror.... .... "

Acme	62 days.
Currant	62 "
Foote's Hundred Days. *d.*	63 "
General Grant	63 "
Paragon	63 "
Green or Golden Gage	64 "
New White Apple. *e.*	65 "
Large Smooth Red	65 "
Hathaway's Excelsior	67 "
Golden Trophy	67 "
Trophy	70 "
Mammoth Leaf. *f.*	71 "
Powell's	72 "
Fejee	77 "
Arlington	78 "
Tomato de Laye. *g.*	

a. Seed bought under this name, but the fruit was so large that it may possibly have been Red Plum.

b. The fruit of Little Gem is larger than Red Plum but yet very much smaller than Conqueror and Canada Victor. Its earliness is its best point, but in addition to this the vines are very productive and the fruit is smooth and of good flavor.

c. Seed purchased as "extra selected."

d. There is no important difference between Hubbard's Curled Leaf and Foote's Hundred Days. In both, the vines are small and bear heavily. The fruit ripens early but is very much furrowed or wrinkled.

e. The fruit of New White Apple is rather small and not produced abundantly, but is white, smooth and very mild in flavor. There is, however, little demand for tomatoes of any color other than red, and none appear to possess any advantage over the red ones.

f. The Mammoth Leaf is a rather large, coarse growing and unproductive variety. The fruit is of a dark red or purple color, but rotted about as fast as it ripened.

g. Tomato de Laye is peculiar in having a single stout upright stem. It bears but sparingly and none of the fruit ripened before frost.

FARM EXPERIMENTS.

These include experiments on—

Field Beans,	Field Corn,	Winter Wheat,
Spring Wheat,	Oats,	Field Peas,
Beets for Stock,	Potatoes,	Winter Rye,
Spring Rye,	Barley.	Times of sowing Wheat.

With wheat especially, the trial of varieties has been very extensive and careful.

Some of these experiments are detailed in the following pages:

FIELD BEANS.

Nine varieties were planted. The soil was sandy, plowed in autumn of 1877, and thoroughly harrowed before planting. The rows were marked at thirty inches, and furrows opened with single shovel plow. The seed was dropped in continuous rows by a Planet seed drill, and covered with the shovel plow.

The cultivation consisted in the use of Thomas' smoothing harrow as often as the weeds sprouted, until the beans appeared above ground, after which the fifth tooth cultivator was run between the rows. The hoe was only used to cut out such weeds as could not be reached by the cultivator.

The beans were planted May 25th, and May 27th. The results of the trial are shown in the following table:

	YIELD PER ACRE.		No. days planting to ripening.
	Seed.	Straw.	
	Bushels.a	*Pounds.*	
California Pea *b* / White Pea	8.8	1,656	102
White Pea *c*	12.3	1,177	84
Navy	14.3	....	80
White Medium	17.0	....	78
White Marrow	10.2	1,530	93
White Kidney *d*	9.9	1,460	95
Red Kidney *d*	13.0	....	88
Early Manley *e*	15.8	1,087	77

(*a*.) Of sixty-two pounds each.

(*b*.) These two lots (California Pea and White Pea) were obtained from Hollister, Carter & Co., and J. J. H. Gregory, under the above names respectively. After careful examination they were decided to be the same. A high wind mixing them after they were pulled, rendered it necessary to thresh them together. The same cause shelled many, and doubtless explains in part, at least, the low yield. The vigor of the vines and their lateness in maturing, will be, however, serious objections unless they prove superior in yield.

(*c*.) These, White Pea, were from R. H. Allen & Co.

(*d*.) The White and Red Kidney are tall and upright, bearing the pods clear of the ground and showing no tendency to run.

(*e*.) The seed of the Early Manley was furnished by G. E. Starkweather, of Minneapolis, and was raised in Orleans county, N. Y., where it was reputed to be very early and productive. Superiority in these respects does not, however, appear to be well sustained in this trial. It is claimed to be a variety of the White Medium, which it closely resembles.

FIELD CORN.

Seven varieties were planted, but owing to the fact that they were planted in different places to prevent mixing, and consequently on different soils they cannot all be compared with each other.

I.

Canada Early Yellow Flint, Adams Early Dent and Silver Laced Pop Corn were planted on sandy soil, plowed in autumn of 1877 and thoroughly harrowed before planting. These were planted in rows 3½ feet apart, and hills 2½ feet apart in the row, three kernels to the hill.

The following table gives the principal points of interest :

	No. days fr'm planting until fit to cut.	Yield per acre, *a* Bushels.	Size of stalks.	Size of ears.	Length of ears.
Canada Early Yellow Flint...	104	38 0	Medium.	Small.	Short.
Adams Early Dent............	110	52.6	"	Medium.	"
Silver Laced Pop.............	114	26.8	Large.	Small.	"

a. Of 72 lbs. each in the ear.

In husking the Canada Early Flint the frequent breaking of the ear so as to leave a portion on the stalk is a serious objection ; but where quick growth and early maturity are required it may yet be desirable. The yield may be greatly increased by closer planting which the small size of the stalks readily permits.

II.

Compton's Early Field and White Dent were planted on sandy soil, in hills 3 feet apart, and the rows 3½ feet apart, 3 or 4 kernels per hill. The following table exhibits the principal results :

	No. days fr'm planting until fit to cut.	Yield per acre, Bushels. *a*	Size of stalks.	Size of ears.	Length of ears.
Compton's Early Field *b*.....	117	31.3	Large.	Medium.	Long.
White Dent....................	117	44.2	"	Large.	Short.

a. Of 72 lbs. each.

b. Difficulty in breaking off the ears in husking is a serious objection to Compton's Early Field.

III.

Speckled Dent and Yellow Flint were planted on sandy loam, in hills 2 feet apart and rows 3½ feet apart, 3 kernels per hill. The results are exhibited in the following table.

	No. days fr'm planting until fit to cut.	Yield per acre, Bushels. *a*	Size of stalks.	Size of ears.	Length of ears.
Speckled Dent.................	105	59.9	Large.	Large.	Short.
Yellow Flint..................	105	63.5	Medium.	Small.	Long.

a. Of 72 lbs. each.

WINTER WHEAT.

Four varieties were sown Sept. 19th, 1877, and the 5th three days later. So sandy and plowed just before sowing. The following table exhibits the resul of the trial :

	YIELD PER ACRE.		When Ripe
	Grain, Bushels.	Straw, Pounds.	
Jenning's White *a*	23.1	2265	July 15.
Clawson White *b*	21.9	2574	July 15.
Square Head	5.9	1373	July 19.
Fultz	19.8	1857	July 12.
White	19.6	1761	July 15.

a. It was the design that all the varieties should enjoy an equal chance ; bu through miscalculation a narrow strip of Jenning's White was sown on groun on which corn had been manured in the hill. The effect of the manure wa plainly visible, and doubtless was the cause of the superior yield of this variet over the Clawson.

b. From the opening of spring until ripening, the Clawson presented the mo vigorous and uniform appearance.

SPRING WHEAT.—I.

White Fife wheat was sown Nov. 2d and Dec. 28th, 1877, and March 28th, 187 with a view of testing the assertion that wheat sown late in autumn, so late th it would not germinate until spring, would do better than that sown in the usu season. Soil and treatment precisely the same in all respects save in the time sowing. The following table exhibits the results, in acres:

Date of Sowing.	YIELD PER ACRE.		When Ripe.
	Grain.	Straw.	
	Bushels.	*Pounds.*	
November 2, 1877	12.1	1972	July 19
December 28, 1877	17.1	2665	" 19
March 28, 1878	22.6	3781	" 22

SPRING WHEAT.—II.

Seventeen varieties were sown on clayey loam, March 27th. The land plowed in autumn of 1877 and thoroughly harrowed before sowing. T was sown with a seeder and covered with the harrow. The following ta hibits the results of the experiment:

	YIELD PER ACRE.		When Ripe.
	Grain.	Straw.	
	Bushels.	*Pounds.*	
Dominion	14.8	1947	July 22
Mediterranean	18.8	1897	" 23
Rio Grande	15.1	1726	" 23
Scotch Fife (seed from Can. '76)	14.9	1982	" 23
Golden Globe or Redfern	14.3	2250	" 22
Scotch Fife (Minn. seed)	16.6	1956	" 23
White Fife, *a*	18.1	2441	" 25
Lost Nation	19.1	2323	" 23
Prussian White, *b*	17.7	2373	" 25
China Tea	20.6	1947	" 23
Brooks	16.6	2328	" 23
Judkin	20.4	2177	" 23
Scotch Fife (Minn. seed) *c*	17.4	1983	" 23
Egyptian	12.4	1906	" 23
Touzelle	15.7	1903	" 19
Canada Club	16.3	1751	" 19
Golden Drop	13.1	1739	" 19
China Spring	14.1	1937	" 22

a. Only the Fife varieties are hard wheats. The White Fife has been tested by many farmers the past season and so far as heard from they are all well pleased with it. It is a hard wheat though not so hard as the common Fife. The millers are reported, however, as speaking unfavorably of it.

b. The Prussian White is the same as White Fife or so closely resembles it in grain, straw and chaff as not to be distinguishable from it. It will not be sown again as a distinct variety.

c. This being the standard of comparison two plats were sown in order that none of the others might be too far removed from it.

SPRING WHEAT.—III.

Two varieties, sown one day later and in a different manner from those in II. The soil and its preparation was the same, but in sowing the ground was marked off in rows 15 inches apart, furrows made with a hoe, 1½ to 2 inches deep, the seed dropped at the rate of about six kernels to the foot, and covered with a hoe. While young, the grain was cultivated twice with a wheel hoe. The results were as follows:

	YIELD PER ACRE.		When ripe.
	Grain.	Straw.	
	Bushels.	*Pounds.*	
Australian Club	11.7	1479	July 22
Champlain	16.0	2185	" 25

SPRING WHEAT.—IV.

One variety sown on sandy soil March 14th. Land plowed in autumn of 1877 and thoroughly harrowed before sowing. Manner of sowing and cultivation the same as in III. The following was the result:

	Yield per acre.		When Ripe.
	Grain.	Straw.	
	Bushels.	*Pounds.*	
Australian Club...............	15.9	2036	July 19

SPRING WAEAT—V.

Four varieties sown March 13th in quantities too small to admit of computing the yield. The soil and its preparation the same as in IV. The manner of sowing and the cultivation the same as in III, except that the kernels were planted about six inches apart. The results are indicated in the following remarks:

Peace River—The seed was obtained from the Peace River country northwest of Winnipeg, through P. B. Nettleton, Esq., of the Minneapolis Harvester Works. The seed was reddish in color, large and soft. It grew well and escaped serious injury from rust, though in close proximity to the following varieties. The straw was of medium length, stiff and upright. The head was bald, of medium length, and well filled. The chaff white. But this trial gives no safe indication of its value as wheat is ordinarily grown.

Oregon Little Club, Oregon Common Club and Chili Club—These varieties together with the Australian Club in III and IV were obtained from Salem, Oregon, through D. Edwards, Esq., of Minneapolis. These three varieties were attacked with rust soon after heading so badly as to effectually prevent the filling of the heads, and thus to cause the ruin of the crop. While they might do much better another season, and on different soil, yet there is every reason to believe that they cannot resist rust and other diseases so well as the other varieties we now have.

SPRING WHEAT—VI.

Ten varieties sown April 12th. Soil very sandy; its preparation the same as in IV. The manner of sowing and the cultivation the same as in III. except that after marking the seed was sown with a Planet seed-drill. The following table contains the names of the varieties and exhibits some of the results:

	YIELD PER ACRE.		When ripe
	Grain.	Straw.	
	bush.	*lbs.*	
Chili	......	......	July 27
Club	......	......	" 23
Siberian	......	......	" 27
Australian	......	......	" 27
Oregon Club	......	......	" 23
Sonora	......	......	" 19
Scotch Fife (Minnesota Seed)	13.9	3,484	" 25
Defiance	8.1	3,302	" 27
Champlain	7.7	3,534	" 21
Odessa	7.8	3,153	" 30

All of these varieties were attacked by the rust more or less severely, the Scotch Fife, as would appear from the yield, least of any. The results of the trial with the last three varieties are sufficiently indicated by the table.

The seed of the first six varieties was obtained from California through J. T. Lucas, Esq., of Minneapolis. The quantity of each was too small to admit of computing the yield. They were all attacked by the rust more severely than the Scotch Fife sown at the same time and growing beside them, Oregon Club and Sonora being injured the most.

SPRING WHEAT—VII.

Three varieties sown April 6th, soil sandy at one end of the plats, and wet and cold at the other end. Preparation of soil and manner of sowing same as in II. The following table shows the results:

	YIELD PER ACRE.		When ripe
	Grain.	Straw.	
	bush.	*lbs.*	
Saxon Fife	7.5	1,287	July 24
Scotch Fife (Minnesota Seed)	7.7	1,488	" 22
Russian	7.9	1,380	" 23

SPRING WHEAT—VIII.

Two varieties sown April 9th. Soil same as in VII. Preparation of soil and manner of sowing same as in II. The following table shows the results:

	YIELD PER ACRE.		When ripe
	Grain.	Straw.	
	bush.	*lbs.*	
Scotch Fife (Minnesota Seed)...................	4.2	940	July 29
Sherman...............................	5.9	1,630	" 23

The Sherman wheat, it will be seen, is remarkable for its earliness, while in this experiment at least it appears to be somewhat superior in yield to Scotch Fife. The grain is soft and the chaff bearded, the only objections noted.

WHEAT—FOUR YEARS' EXPERIMENTS.

To facilitate comparison the results of all the experiments with varieties of wheat for four years, including those detailed in the foregoing pages, are condensed in the following tables:

	Very poor Sandy Soil. 1875.	Loamy Soil. 1876.	Poor Sandy Soil. 1877.	Clayey Loam. 1878. II. *b*	White Fife Wheat. 1878. I. *c*.	Winter Wheat. *d*. 1878.
	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.
Arnotka......................	3.2	8.7	Poor. *a*.	....	....	....
Oran........................	5.0	5.9	Poor. *a*.	....	....	....
Scotch Fife (Minn. Seed).....	5.9	16.6	13.5	17.0 *e*	....	....
China Spring.................	5.9	....	....	14.1	....	....
Mediterranean...............	7.4	13.4	11.2	18.8	....	....
Mixture of above five.........	8.3	....	....	....	....	....
Golden Drop..................	....	15.9	....	13.1	....	....
Canada Club..................	....	9.4	....	16.3	....	....
Golden Globe.................	....	17.0	11.7	14.3	....	....
Scotch Fife (Seed from Can'a)	....	17.3	12.9	14.9	....	....
Dominion....................	....	18.3	9.9	14.7	....	....
Lost Nation..................	....	15.6	Good. *a*.	19.1	....	....
Rio Grande...................	....	....	12.7	15.1	....	....
White Fife...................	....	....	11.4	18.1	....	....
Touzelle.....................	....	....	3.2	15.7	....	....
Egyptian.....................	....	....	Poor. *a*.	12.4	....	....
Prussian White...............	....	....	....	17.7	....	....
China Tea....................	....	....	....	20.6	....	....
Brooks.......................	....	....	....	16.6	....	....
Judkin.......................	....	....	....	20.4	....	....
Sown Nov. 2, 1877............	....	....	....	....	12.1	....
Sown Dec. 28, 1877...........	....	....	....	....	17.1	....
Sown March 28, 1878..........	....	....	....	....	22.6	....
Jennings' White..............	....	....	....	....	....	22.1
Clawson......................	....	....	....	....	....	21.9
Square Head..................	....	....	....	....	....	5.9
Fultz........................	....	....	....	....	....	19.3
White........................	....	....	....	....	....	19.6

a. Sown in quantity too small to admit of computing the yield.
b. For details of culture see "Spring Wheat II," in foregoing pages.
c. For details of culture see "Spring Wheat I." in foregoing pages.
d. For details of culture see "Winter Wheat," in foregoing pages.
e. Average of two plats.

	Clayey loam, sown Mar. 28, 1878. (III.) *a.*	Sandy soil sown Mar. 14, 1878. (IV.) *a.*	Sandy soil sown Mar. 13, 1878. (V.) *a.*	Very sandy soil sown April 12, 1878. (VI.) *a.*	Sandy soil sown April 6, 1878. (VII.) *a.*	Sandy soil sown April 9, 1878. (VIII.) *a.*
	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.	Bush. Per acre.
Australian Club	11.7	15.9	....	....	....	....
Champlain	16.0	....	....	7.7	....	....
Peace River	....	....	Good. *b*	....	....	....
Oregon Little Club	....	....	VeryP'r*b*	....	....	....
Oregon Common Club	....	....	"	....	....	....
Chili Club	....	....	"	....	....	....
Chili	....	....	....	Poor. *b*	....	....
Club	....	....	....	"	....	....
Siberian	....	....	....	"	....	....
Australian	....	....	....	"	....	....
Oregon Club	....	....	....	VeryP'r*b*	....	....
Sonora	....	....	....	"	....	....
Scotch Fife, Minn. Seed	....	....	....	13.9	7.7	4.2
Defiance	....	....	....	8.1	....	....
Odessa	....	....	....	7.8	....	....
Saxon Fife	....	....	....	....	7.5	....
Russian	....	....	....	....	7.9	....
Sherman	....	....	....	....	....	5.9

a. For details of sowing and cultivation see "Spring Wheat" with corresponding number in foregoing pages.
b. Quantity sown too small to admit of computing the yield.

OATS.

Eleven varieties were sown March 26th. The soil was sandy loam and underlaid with sand—a June grass sod broken in 1877. It was thoroughly harrowed in autumn of 1877 and again before sowing, but much June grass remained, notwithstanding, unsubdued. The following table exhibits the results:

	YIELD PER ACRE.		When Ripe.
	Grain.	Straw.	
	Bushels.a	*Pounds.*	
Silver White Queen	18.2	622	July 23
White Schonen	28.8	1,072	" 24
Canadian	33.6	1,446	" 19
Brunswick	35.2	1,672	" 19
Waterloo	23.7	1,157	" 18
Black Norway	27.7	1,184	" 27
Probsteir	24.3	966	" 27
Excelsior	27.4	1,100	" 20
White Dutch	28.6	1,062	" 24
Alvey	21.2	966	" 19
Chinese Hulless	12.5	1,230	" 21

(*a.*) Of 32 pounds each.

The following table contains the results of four trials with varieties of oats, together with averages for four, three and two years. These data enable us to indicate the most productive varieties with far more confidence than we could from a single trial, which is often contradicted by the succeeding one.

	Yield Per Acre—Bushels.*				Average Yield for		
	1875.	1876.	1877.	1878.	4 Yrs. '75-'78.	3 Yrs. '76-'78.	2 Yrs. '77-'78.
Silver White Queen	14.0	30.6	23 5	18.2	22.0	24.7	20.8
White Schonen	17.8	36.2	29.6	28.8	28.1	31.5	29.2
Canadian	17 5	38.7	33.4	33.6	30.8	35.2	33.5
Black Norway	18.6	39.6	32.5	27.7	29.8	33.2	30.1
Probsteir	20.6	38.7	32.5	24.3	29.0	31.8	28.4
Excelsior	13.1	39.6	25.4	27.4	26.3	30.8	26.4
Brunswick	....	30.6	29.6	35.2	....	31.8	32.4
Waterloo	....	38.7	24.1	23.7	....	28.8	23.9
White Dutch	....	....	26.9	28.6	....	....	27.7
Chinese Hulless	....	....	11.1	12.5	....	....	11.8
Alvey	....	....	....	21.2	....	....	....

*Of thirty-two pounds each.

Arranging the varieties in the order of their average yields, we have the following list:

Order of average Yield for 4 years.		Order of average yield for 3 years.		Order of average yield for 2 years.	
Canadian	30.8	Canadian	35.2	Canadian	33.5
Black Norway	29.8	Black Norway	33.2	Brunswick	32.4
Probsteir	29.0	Probsteir	31.8	Black Norway	30.1
White Schonen	28.1	Brunswick	31.8	White Schonen	29.2
Excelsior	26.3	White Schonen	31.5	Probsteir	28.4
Silver White Queen	22.0	Excelsior	30.8	White Dutch	27.7
		Waterloo	28 8	Excelsior	26.4
		Silver White Queen	24.7	Waterloo	23 9
				Silv'r White Queen	20.8
				Chinese Hulless	11.8

The most productive varieties are shown by these lists to be

1. Canadian.
2. Black Norway.
3. Probsteir.
4. Brunswick.
5. White Schonen.

Other methods of comparison lead to the selection of the same varieties.

PEAS—CANADA FIELD.

The same variety was sown in two different places, neither of which were suitable for wheat. The land was plowed in both cases in autumn of 1877, and thoroughly harrowed before sowing. Seed sown broadcast with seeder and covered by harrowing with Thomas' smoothing harrow. The following table exhibits the results:

	Yield per Acre.		When sown.	When ripe.
	Grain.	Straw.		
	*Bushels.**	*Pounds.*		
Very sandy soil...............	20.1	2,066	March 12	July 15
Vegetable loam underlaid with sand.....................	17.5	....	April 4	August 3

*Of sixty pounds each.

BARLEY.

Three varieties were sown March 27th. Soil, clayey loam; plowed in autumn 1877, and thoroughly harrowed before sowing. Seed sown with seeder and covered with Thomas' smoothing harrow. The following table exhibits the results:

	Yield per Acre.		When Ripe.
	Grain.	Straw.	
	*Bushels.**	*Pounds.*	
Chevalier.....................	27.7	1,638	July 18
Two Rowed..................	27.2	1,594	July 16
Four Rowed..................	25.0	1,500	July 12

*Of forty-eight pounds each.

The Chevalier is a two-rowed variety, the seed of which was received two or three years ago from the United States Department of Agriculture. It does not appear to be more productive than the common two-rowed, but the berry is remarkable for its plumpness and light color.

SPRING RYE.

The same variety of Spring Rye was sown in three places, none of which were considered suitable for wheat. The following table exhibits the results:

	Yield per Acre.		When Sown.	When Ripe.
	Grain.	Straw.		
	Bushels	*Pounds*		
On very sandy soil.......................	11.0	1,421	March 12	July 15
Sandy loam underlaid with sand..........	10.8	1,160	March 26	July 17
Vegetable loam underlaid with sand......	15.0	....	March 29	July 17

WINTER RYE.

Two varieties were sown Sept. 27th, 1877, on sandy soil, plowed shortly before sowing. The following table exhibits the results of the experiment:

	Yield per Acre.		When Ripe.
	Grain.	Straw.	
	Bushels.	*Pounds.*	
Amber *a*.....................	24.1	3,049	July 7
White..........................	25.1	2,665	July 10

(*a*.) At the opening of spring and throughout the remainder of their growth the Amber presented the most uniform and vigorous appearance. A frequent observer would not hesitate to say that this was the hardiest and would yield the best crop. The result, therefore, was something of a surprise.

VARIETIES OF POTATOES.

Thirty-four varieties were planted, twenty-eight of them *both* on clayey loam and on sandy soil. In both cases the land was plowed in autumn of 1877, and thoroughly harrowed in the spring. The land was marked for the rows three feet apart and furrows were made with a single shovel plow.

The seed was cut, leaving as nearly as possible a single eye to each piece, and the pieces were dropped in the furrows about 12 inches apart, after which they were covered with the shovel plow. No manure was applied in any manner.

The cultivation consisted in the use of Thomas' Smoothing Harrow, as often as the weeds appeared, until the potatoes were well above ground. The 5-tooth cultivator and double shovel plow were then used between the rows, and before the vines fell down they were ridged with the single shovel plow. The hoe was only used to cut out weeds where the cultivator could not reach them.

They were planted on clayey loam April 23d, and on sandy soil April 29. The former were dug Oct. 7th, and the latter Oct. 16th.

	ON CLAYEY LOAM.		Average Size on Clayey Loam.	ON SANDY SOIL.		Average Size on Sandy Soil.	Ripe on Sandy Soil.	Shape.	Color.	Depth of Eyes.
	Large, Bushelsa	Small, Bushels.		Large, Bushels.	Small, Bushels.					
Peerless	115.2	18.7	Medium.	58.6	12.1	Medium.	Aug. 28.	Oblong.	White.	Shallow.
Shaker Fancy	161.4	11.7	Large.	28.2	5.1	"	Sept. 5.	Roundish.	Rose.	Deep.
Eureka	114.1	16.1	Medium.	52.3	11.9	Below Med'm.	"	Oblong.	White.	"
Late Rose	154.5	19.1	"	74.2	12.5	"	Aug. 26.	Roundish.	Rose.	Shallow.
Little Giant	118.7	8.1	Large.	44.7	7.4	Medium.	"	Oblong.	White.	Medium.
Excelsior	116.8	23.0	Medium.	37.9	18.3	"	"	Roundish.	"	Deep.
Dunmore's Seedling *c*	140.7	19.7	"	75.8	14.1	"	"	Oblong.	"	Shallow.
Calcutta Seeding	154.1	23.8	Above Med'm.	93.7	20.3	"	"	"	"	"
Paragon	48.6	23.3	Very Small.	41.0	34.3	Very Small.	Aug. 19.	"	"	"
Fluke	176.2	36.5	Above Med'm.	94.8	27.2	Medium.	Aug. 26.	"	"	Deep.
Burbank's Seedling	135.0	14.2	Medium.	51.3	14.0	"	Aug. 28.	Long.	"	Very Shallow.
Cayuga Chief	121.7	7.3	Above Med'm.	35.0	7.0	"	Aug. 26.	"	"	Shallow.
Victor	172.6	14.5	Large.	52.9	12.7	Large.	"	Roundish.	Purple.	"
Brownell's Beauty	105.3	9.3	"	76.9	14.7	"	Aug. 28.	Oblong.	Red.	"
Ruby	59.6	13.4	Below Med'm.	98.3	24.0	Medium.	Aug. 15.	"	"	"
Improved Peachblow	32.7	23.9	Very Small.	18.7	16.5	Very Small.	Sept. 5.	Round.	Rose & White.	Medium.
Superior	91.6	11.7	Below Med'm.	44.1	17.9	Below Med'm.	Aug. 26.	Long.	Red.	"
Snowflake	63.1	13.2	"	99.8	30.2	"	Aug. 21.	Oblong.	White.	Shallow.
Extra Early Vermont	64.6	22.0	"	124.2	24.2	"	Aug. 19.	"	Light Rose.	"
Early Rose	39.6	11.2	Small.	114.5	31.5	Medium.	Aug. 5.	"	Rose.	"
Alpha	...	...	...	...	...	...	...	...	...	...
Early Ohio	27.7	65.8	Medium.	114.6	15.4	Above Med'm.	Aug. 5.	Roundish.	Light Rose.	Shallow.
Trophy	49.8	12.0	Small.	...	...	...	...	"	Red.	Very Shallow.
Bliss' Triumph	48.2	15.5	"	...	...	...	...	"	Red.	Shallow.
Compton's Surprise	107.5	16.2	Below Med'm.	66.3	10.8	Medium.	Sept. 5.	Oblong.	Purple.	Deep.
St. Lawrence *d*	112.9	16.8	Medium.	114.6	12.2	"	Aug. 28.	"	Red.	Shallow.
Iowa Beauty	31.6	21.8	Very Small.	...	...	...	...	"	White.	"
Success	36.1	11.2	Small.	...	...	...	...	Long.	"	"
White Ash	56.0	10.6	Medium.	69.4	18.5	Medium.	Sept. 5.	Roundish.	"	Medium.
Early Wideawake (Adv'ce)*e*	78.9	16.9	Above Med'm.	129.6	22.2	Above Med'm.	Aug. 15.	Very Long.	Rose.	Shallow.
Harlequin	49.0	9.7	Medium.	...	...	...	...	Oblong.	"	"
Centennial	...	...	...	32.0	10.5	Medium.	Aug. 29.	Roundish.	Red.	"
Mahopac Seedling	...	...	...	57.7	18.3	Below Med'm.	Sept. 5.	Oblong.	Light Rose.	"
Tioga	...	...	...	82.0	8.8	Above Med'm.	"	"	White. *f*	Deep.

a. Bushels of 60 lbs. in every case.

b. The time when the vines appeared dead.

c. Dunmore's Seedling has been for two years previous the best producer. No satisfactory explanation can be given for the comparatively low yield this year.

d. So far as this trial goes, it indicates a singular adaptation of the St. Lawrence to both heavy and light soil.

e. The Early Wideawake is the best yielding early potato, while its size is equal or superior to that of other early varieties.

f. With pink or rose colored eyes.

It will be noticed that the best producers on clayey loam are all late varieties.

BEETS FOR STOCK.

Planted on clayey loam May 7th. Land plowed in autumn of 1877 and again just before planting. After harrowing thoroughly the seed was planted in rows 30 inches apart. When large enough the plants were thinned to about 12 nches in the row. Cultivation consisted in the use of cultivator and hoe to destroy weeds. No manure was applied. The following table exhibits the results:

	Yield per acre in bush. of 60 lbs. each.
Mammoth Long Red Mangold	287.7
Long Red Mangold	188.0
Long Yellow Mangold	222.2
Champion Intermediate Mangold. *a*	38.8
Red Globe Mangold	225.1
Carter's Orange Globe Mangold	136.9
Webb's New Kinver Yellow Globe Mangold	172.7
Yellow Ovoid Mangold	192.3
Red Giant Ovoid Mangold	197.5
Imperial Sugar Beet	164.4
White Silesian Red Top Beet	234.9
White Silesian Green Top Beet	221.8
Lane's Improved American Sugar Beet	344.0
White Green Top Sugar Beet. *b*	288.6

a. The seed of Champion Intermediate germinated but poorly and there were many and long vacant spaces in the rows.

b. This variety, White Green Top Sugar Beet, was sent out by the Commissioner of Agriculture with the view of determining the value of the beet for sugar in the United States. Examination by Professor S. F. Peckham revealed in the juice of these beets 15.63 per cent. of cane sugar (saccharose).

FERTILIZERS.

No experiments with fertilizers were made in 1878, but it has been considered worth while to reproduce those of 1875 and 1877 in the following form:

	Quantity of fertilizer per acre.	Cost of fertilizer per acre.	Cost fertilizer, transportation included, per acre	Increased yield per acre over "no manure." Grain.	Straw.
WHEAT—1875.	*Pounds.*			*Bush.*	*Lbs.*
No manure *b*					
Bone flour	310	7.50	10.35	0.7	50 *a*
Superphosphate of lime	300	7.50	10.26	1.2	00
Animal fertilizer	417	7.50	9.79	1.3	a2
Peruvian guano	200	7.50	9.96	3.9	648
WHEAT—1877.					
Rectified Peruvian guano	505.9	16.42	21.47	5.1	607
Stockbridge manure for wheat	458.2	15.83	20.41	8.7	1,012
No manure *c*					
Superphosphate of lime	802.2	14.76	23.33	4.7	351
Ashes	35.7	5.35	5.35	0.5	107 *a*
Gypsum	595.2	4.46	4.46	0.0	84 *a*
POTATOES—1877.				Large. bushels.	Small. bushels.
Rectified Peruvian guano	381.9	12.75	16.56	9.5	6.0
Stockbridge manure for potatoes	424.7	12.75	16.99	7.5	1.6
No manure *d*					
Superphosphate of lime	762.1	12.66	20.02	1.3	1.7 *a*
Ashes	33 bu	5.09	5.09	4.4	3.2
Gypsum	637.3	4.81	4.81	5.2	3.2

(*a*.) Decrease in these cases instead of increase.

(*b*) The soil in this experiment was completely exhausted so that the total yield with "no manure" was 3.3 bushels of grain, and 762 pounds of straw.

(*c*) Total yield with "no manure", 11.4 bushels of grain and 762 pounds of straw.

(*d*.) Soil sandy and badly affected by drouth, so that the total yield with "no manure" was only 38.0 bushels, large, and 15.2 bushels, shall potatoes.

IMPLEMENTS.

Several trials of farm implements have been made on the in our presence. The Limber Jack Harrow, Taylor Harrow, Harrow, Clipper 14-inch plow, Northwestern Rotary Plo Plow-Pole and Wheel Attachment have been thus tested. detailed report of these trials;

LIMBER JACK HARROW.

This harrow consists of short, thick and heavy blocks together by iron rods passing through them, on which are a keep the blocks at proper distance from each other. On one are cast-iron knives or cutters, while from the other side the obliquely backwards. Thus either the cutters or the teeth by simply turning the harrow over.

The claims made for this harrow are briefly stated as foll Jack Harrow will do better work under all circumstances, land, than any other harrow."

This harrow was first tried for levelling tussocks on a wet ison with a common Scotch Harrow consisting of two sectic weighted to make it draw about equally heavy with the Limber Jack was passed twice over the ground with the cut twice with the teeth down. On another strip it was passed teeth alone. In both cases the same amount of labor with did the work equally well.

The Limber Jack was next tried crosswise of stiff unrotted autumn previous. The ground was passed over once with t with the teeth. The same amount of labor with the Scotch of levelling and pulverizing equally well and did not turn u than did the Limber Jack.

The Limber Jack was then tried lengthwise of rough sod roots, plowed the autumn previous. Four strips side by sid were measured off. No. 1 was reduced to an ordinary con Harrow, which occupied 18 minutes. No. 2 was worked wi the same length of time, 12 minutes with cutters down and down. No. 3 was worked 18 minutes with Thomas' Smooth was worked 18 minutes with the Limber Jack, teeth down. the Limber Jack was in neither case superior to that done b and was in both cases decidedly inferior to that done by the Harrow.

The fourth trial of the Limber Jack was made on clayey loam—st plowed the autumn previous. Three strips of equal width were m

and the time devoted to each was the same. On one the Limber Jack was used, cutters down; on another with teeth down; on the third Thomas' Smoothing Harrow was used. The work done by the last was better than in either of the other cases.

THE TAYLOR HARROW.

This harrow consists of three sections, each containing twenty-four teeth, each section being entirely independent of the others, but attached by short chains to a cross bar in front, to which bar the team is also attached. Its light and trim appearance, the broad sweep it takes and the square draft, one part not falling behind another—these points secure in advance for the harrow a very favorable opinion.

This harrow was first tried in comparison with Thomas' smoothing harrow for smoothing and pulverizing land plowed from stubble the autumn previous. The Taylor harrow did good work, but not equal to that done by the other harrow.

Two trials were made on stiff sods recently plowed. In each trial the team was repeatedly shifted from one harrow to the other, and weights were added to the Taylor harrow as well as to the other. In both trials the same amount of labor with Thomas' smoothing harrow secured better and deeper pulverization, though in the absence of this close comparison the working of the Taylor harrow would be pronounced very good.

The result of these trials, though unexpected, may yet be explained. The teeth of the Taylor harrow are perpendicular. They were observed to catch slightly in the sod, and when jerked loose by the team the whole section made a short jump or skip. The teeth of Thomas' smoothing harrow, on the contrary, are set obliquely, slanting backwards, and as there was no catching there was no jumping or skipping, and the teeth were constantly in contact with the soil doing their work.

THOMAS' SMOOTHING HARROW.

This harrow has small cylindrical teeth set as above described, the whole consisting of three sections joined to each other by iron rods and to a cross-bar in front by short chains. It has now been used on the farm for three years, and the more it is used the more it commends itself. Its equal has not yet been presented for trial.

COMBINED PLOW-POLE AND WHEEL ATTACHMENT.

This consists of a pole similar to a wagon pole, only lighter, to the rear end of which is attached on the under side a small plow wheel and apparatus for conveniently guaging the depth, and to the upper side the whiffletrees. The advantages claimed for this apparatus are as follows:

"First—The plow runs steadier, not being much affected by stones, stray side steps of the team or sawaying of the whiffletrees, which are attached to the pole.

"Second—The plow is moved much easier laterally; being held in the upright position by the pole and its connections, and being unencumbered by whiffletrees, there is a greater leverage in favor of the operator.

"Third—The traces are free from trembling, vibration and shake, and do not chafe the breasts of the horses, or irritate them by coming in contact with their heels. The whiffletrees being elevated and supported by the pole, the horses cannot step over or upon the traces.

"Fourth—The plow can be backed by the team, and it follows the steps of the horses at the ends of a piece being back-furrowed, and of itself comes into proper position to begin the returning furrow.

"Fifth—The draft is from twelve to fifteen per cent. less than without the attachment.

"Sixth—It can be attached to harrows, cultivators

The same plow was used alternately with this atta nary plow wheel placed under the beam.

First, Second and Fifth. These claims were not su personal trial and observation. The dynamometer, h

Third In plowing, or any other work, where the is vibration or shaking of the whiffletrees to chafe the rarely to irritate by coming in contact with their heel

Fourth. In backing the attachment gives conside there is very much of this to do, it might be an obje the ends the attachment does not yield any material plow to follow the team, while in its effect on the w up and the other down, it is a positive inconvenience.

Sixth. Not tested, but its use on harrows and cul undesirable, because of clogging of the wheel in loos

The implement is one that is commended by its ap after a few weeks or a season's use it is likely to rot for want of positive advantages.

CLIPPER PLOW—(14 inch)

Manufactured by Laraway, King & Co.

This plow was not tested in the usual manner by working with that of another plow in the same soil it did such excellent work, both in breaking sod and ing perfectly in a soil in which no other plow had eve wards purchased for regular use on the farm. Co occasion to regret the purchase, though spots have be conditions of moisture even this plow has failed to "c

Probably it would be difficult to find a soil affording of the Experimental Farm, in which no plow has ye fectly in all states of moisture and dryness.

NORTHWESTERN ROTARY GANG

It would be difficult to give any description of this vey an idea of its construction and appearance. tested in immediate competition with another plow s trial only can be stated.

It was tested in the worst soil the farm affords, an no means favorable. It was drawn by two horses an two furrows were turned at once. The ground was and pulverized, and left more nearly level by this im ever was by an ordinary plow. While the draft was that of two plows taking the same width and runnin this report does not in the least exaggerate the results of this trial, hat only repeated and continued trials and perhaps years of e t

fully test the durability &c., and establish the superiority of an implement of of this character. Plows and plowing would appear, however, to afford a promising field for extensive improvements.

FARM CROPS.

Hay is the only crop to which any attention has been paid without a view to experiment. Of this crop about 50 tons have been put up the past year. From the farm experiments will be obtained about as follows: Twenty-five bush. field beans; 60 bush. oats; 8 bush. winter wheat; 7 bush. winter rye; 12 bush. spring rye; 40 bush. spring wheat; 10 bush spring barley; 15 bush. peas; 90 bush potatoes.

IMPROVEMENTS.

Some additional breaking has been done between the barn and the avenue. Something has been done towards subduing that broken in the same locality last year. All of this, being unsuited for experimental work, together with other land of the same character, heretofore under cultivation, has been sown with winter rye and timothy with a view to making it more sightly and more remunerative as meadow.

On the meadow 560 rods of ditch has been dug, a part 2 feet and the remainder 3 feet deep. This has already resulted in improvement to the land thus ditched. It is the plan however to deepen the ditches to 3½ feet, to lay tile in the bottom and refill. Seven thousand feet of tile have been procured for this purpose.

PLANT HOUSE.

The plant house continues in good condition. Mr. Geo A. Wood remains in charge of the same. Its usefulness appears to be fully vindicated by the assistance it affords in teaching botany, the taste for flowers it promotes among the students and the decorations it furnishes to the University grounds and to the buildings both ordinarily and upon public occasions. Its loss would now be very keenly felt.

THE FAIRS.

Exhibitions were made by the College of Agriculture at both the St. Paul and Minneapolis fairs. The exhibits were substantially the same in both places and consisted mainly of grains, seeds and vegetables from the farm, woods and seeds from the museum of agriculture and plants from the plant house. These were arranged with a view to instruction rather than general effect, though the latter was not wholly neglected.

At the close of these fairs the main part of the exhibit at St. Paul was taken to Red Wing and exhibited at the fair at that place. Later it was taken to the Freeborn county fair at Albert Lea. At both places it attracted no small share of attention.

CAMPUS.

No important improvement has been made on the campus the past year. Its appearance has however been greatly improved by the removal of a remnant of fence, the comparative exclusion of stock and loaded teams, the closing of many wheel tracks and their obliteration by growing grass, and the removal of a small house and garden, as well as by the ordinary care which has consisted in mowing twice, and raking and hauling the leaves away once.

CHAS. Y. LACY.

Report of Hon. Peter M. Gideon, in charge of the Fruit Farm of the Department of Agriculture, at Lake Minnetonka.

As Superintendent of the experimental fruit farm, I herewith send the following report of my doings:

To the President of the University.

SIR:—On the 19th of April last I got notice to proceed with the work. On the next day began the clearing, and by the sixth of May had the ground cleared, plowed, and 795 trees set, and two days later under good fence. The trees set were crown and root grafts. About three-quarters have done well, the growth ranging from one to five feet. The loss was occasioned by the heat and dryness where brush and logs had been burned.

The varieties set were our best hardy seedlings, alternate in row, the best long keeping varieties that could be procured, all worked on hardy seedling stock. In same manner I propose to fill vacancies next spring, having on hand the best of stock to do it with.

On another part of the premises I set a few grapes last spring, about one-half being seedlings from our best grapes, the soil and location being all that could be desired, and I expect to set some five or six hundred more next spring.

Adjoining the grapery, and on top of the hill, I intend to set a pear orchard in the spring, the location and soil being just what I want for the purpose.

I will add that the Marblehead Mammoth Sweet Corn, got of your deparment,* yielded enormously, the ears long and large and the finest I ever saw.

The peas from your department were the following, viz.: Carter's first crop, Eugenie, Princess Royal, Veitch's Perfection, Dwarf Blue Imperial, Carter's Surprise, Large Gem, Omega, and Fill Basket. All have done well; all planted May 10th, side by side, and received the same culture—rich land well manured. Carter's First Crop was fit for use in 60 days and the others came in succession about the same as on your printed list, the Eugenie giving largest pods and most of them, the Fill Basket next in point of yield, the balance about an average, and as to quality I could see but little difference—all good.

With respect,

PETER M. GIDEON.

EXCELSIOR, MINN., Nov. 12, 1878.

*College of Agriculsure.

THE GEOLOGICAL

AND

NATURAL HISTORY SURVEY,

OF

MINNESOTA.

THE SEVENTH ANNUAL REPORT.

FOR THE YEAR 1878.

OFFICERS OF THE SURVEY.

N. H. WINCHELL,	State Geologist,	In Charge.
S. F. PECKHAM,		Chemistry.
M. D. RHAME,		Topography.
C. W. HALL,		Assistant Geologist.
P. L. HATCH,		Ornithology.
ALLEN WHITMAN,		Entomologist.
CLARENCE L. HERRICK,		Laboratory Assistant.

Submitted to the President of the University Dec. 31, 1878.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1879

THE BOARD OF REGENTS OF THE UNIVERSITY.

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ATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey. 34 pp. 1860. Reprint from the Wisconsin Reports for 1858. Out of print.

Statistics and History of the Production of Iron, by A. S. Hewitt. 47 pp. 1860. Reprint of a paper read before the American Geographical and Statistical Society, January 31, 1856. Out of print.

Report of Anderson and Clark, Commissioners on the Geology of the State, January 25, 1861. 8vo. 26 pp. Out of print.

Report of Hanchett and Clark, November, 1864. 8vo. 82 pp. Out of print.

Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior, 1866. 8vo. 23 pages.

Report of H. H. Eames, on some of the northern and middle counties of Minnesota. 1866. 8vo. 58 pp. Out of print.

Report of Col. Charles Whittlesey on the Mineral Regions of Minnesota. 1866. 8vo. 52. pp. close type, with wood cuts.

Report of N. C. D. Taylor on the Copper District of Kettle river, incorporating Mr. James Hall's estimate of the copper prospects of that district, 1866. 2. pp. 8vo. Found only in the Executive Documents.

Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June 17, 1871. 8vo. 16 pp.

The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp. with a colored geological map of the state. Published in the Regents' Report for 1872. Out of print.

The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 148 pp. 8vo.; with illustrations.

The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo. with two county maps. Published in the Regents' Report for 1874.

The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington; 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.

The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson; 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the Regents' Report for 1876.

The Sixth Annual Report on the Geological and Natural History Survey, for the year 1877. By N. H. Winchell, with reports on Chemical Analyses by Prof. Peckham, on Ornithology by P. L. Hatch, on Entomology by Allen Whitman, and on the Geology of Rice county by L. B. Sperry; three geological maps and several other illustrations. Also published in the Regents' report for 1877.

MISCELLANEOUS PUBLICATIONS OF THE GEOLOGICAL AND NAT-
URAL HISTORY SURVEY OF MINNESOTA.

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1. CIRCULAR NO. 1. *A copy of the law ordering the survey, and a n*
asking co-operation by citizens and others. 1872.

2. PEAT FOR DOMESTIC FUEL, 1874. *Edited by S. F. Peckham.*

3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOT
A history of all official transactions relating to them, and a statement of th
amount and location, 1874. By N. H. Winchell.

4. A CATOLOGUE OF THE PLANTS OF MINNESOTA; *prepared in 1865*
Dr. I. A. Lapham, contributed to the Geological and Natural History Survey
Minnesota, and published by the State Horticultural Society in 1875.

5. CIRCULAR NO. 2. *Relating to Botany, and giving general directions f*
collecting information on the flora of the State. 1876.

6. CIRCULAR NO. 3. *The establishment and organization of the Museu*
1877.

7. CIRCULAR NO. 4. *Relating to duplicates in the Museum and exchang*

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1878.

To the President of the University:

DEAR SIR—I have the honor to offer the Seventh Annual Report, as required by law, on the progress of the Geological and Natural History Survey of the State.

Very respectfully, your obedient servant,

N. H. WINCHELL.

REPORT.

I.

SUMMARY STATEMENT.

Before the beginning of the field-work for the year the Board of egents took important action relating to the Geological and Nat-ral History Survey of the State, intended to carry out some of e suggestions of the last report.

1st. The State Geologist was relieved from giving instruction the University, and an assistant was appointed to discharge those ties.

2nd. The operations of the survey were transferred to the rthern part of the State.

3d. The zoological and botanical investigations were ordered be kept in abeyance or carried only so far as possible without uch additional expense.

4th. The geological survey proper was ordered to be pushed as pidly as possible, with a view to substantial completion in four ars, and the publication of a couple of volumes of a final report, e on the northern part of the State with the necessary mineral-y, and one on the southern with the necessary paleontology.

5th. The annual reports on the geological work were ordered to brief and synoptical, the details of the survey being reserved for al publication in a more substantial and creditable form.

In consequence of this action the following report is calculated give but an outline of the progress of the survey during the ar.

Mr. C. W. Hall, late of Leipzig, who was appointed an assistant the survey, conducted an independent party in the northern art of the State during September and October, and his prelimin-ry report on the same is herewith transmitted.

Professor Peckham's report on chemical work done tor the survey, and on an expedition for assaying ores on the north shore of Lake Superior, is embraced in the following pages.

Dr. P. L. Hatch submits an annual statement of progress in ornithology.

Identifications of plants in the northern part of the State, and notes on the flora and forest of the same are contributed by Mr. B. Juni who was special botanical collector during a portion of the season of 1878.

Mr. C. L. Herrick, assistant in the laboratory, is engaged on a systematic examination of microscopic entomostraca inhabiting fresh waters in Minnesota. This he has prosecuted for more than a year, and he contributes to the survey the first results of his work.

The Museum report, accompanying this, shows recorded additions to the specimens, and increased facilities for exchanging and working up the material on hand.

The survey is under obligations to President John P. Ilsley, of the St. Paul and Duluth R. R. and Chas. F. Hatch, Superintendent of the Minneapolis and St. Louis R. R., for free transportation on those railroads respectively, and to McLennan and Morison of Duluth, Henry Mayhew, of Grand Marais, and N. T. Wilson and James Caldwell of Grand Portage, for various favors in organizing par-

II.

SKETCH OF THE WORK OF THE SEASON OF 1878.

Before entering on the field-work for the season of 1878, it was decided to give special attention to the economical mineral interests of the northern part of the State, and if necessary, to spend the whole summer in visiting and examining the mineral locations and workings that have been begun in that part of the State. This was published in several of the State papers. It was very soon discovered, however, that the general interest of mining in the State had been over-estimated, and that but very few persons were sufficiently enlisted to desire any examination, or to accompany any geological party to their claims; and in fact, that at the present time there is no actual mining being done at any place in the State. It was at but one point that the owner of any mineral location was found at work on his claim, though at a number of places shallow shafts for trial have been sunk, and at some, a considerable deep excavation has been done in previous years. Still, the original plan was carried out, and all mineral locations of which any information could be obtained, were examined, so far as they were embraced within the territory of the State, and several also in British territory. In addition to the examination of all known mineral locations, the geology proper of the northern part of the State has been carefully observed along some important lines, and about forty-five boxes of specimens have been collected. The work consisted in a careful examination of the coast line of Lake Superior from Duluth to Pigeon river, for geological and lithological data. This occupied the greater part of July and August. During September and October two independent parties were engaged. One was occupied in ascending some of the streams that enter Lake Superior, beginning with those most easterly, and the other in a trip along the international boundary line as far as Basswood lake; thence to Vermilion lake; thence, by the Embarrass river, to the St. Louis river. Descending the

St. Louis to its nearest point of approach to the Mississippi river, this party crossed over to the Mississippi, and descended it as far as Little Falls, in Morrison county, when floating ice and cold weather rendered it impossible to continue the descent by river. The details of these explorations will be given in working up the geology and and lithology of the State. Some of the salient results are given by Mr. Hall in his report accompanying this, and others may be grouped and stated as follows.

(a) Geological Results.

The trend, or strike, of the formations of the northern part of the State, north of Lake Superior, is more nearly east and west than has been supposed. Hence, they cross the coast line at an acute angle, the later formations being toward the south, and the older along the international boundary line. The igneous cupriferous series seems to overlie several formations unconformably, and to be interstratified with some of the later, and especially with a red, shaly sandstone.

The formations that compose the coast line, including the cupriferous rocks which are everywhere the most conspicuous, and for many miles constitute the only visible rock, seem to be something as follows, in descending order.

1. Metamorphic shales, sandstones and quartzyte. These are cut by dykes, and are interbedded with igneous rock. They prevail along the coast from Duluth, an undetermined distance northeastward, and are, perhaps, the formation that Sir W. E. Logan regarded the Quebec group, as they are associated with copper-bearing amygdaloids and traps.

2. Ferruginous and aluminous sandstones. These seem to be metamorphosed into a firm basaltiform red rock, as seen in the Palisades, and at other points. The sandstones may be seen at Black Point, interstratified with igneous rock.

3. A quartzose conglomerate, seen at the Great Palisades and on Portage Bay Island—probably more properly a part of No. 2.

4. The quartzytes and slates of Grand Portage Bay, and eastward to the termination of Pigeon Point.

5. The jasper, flint and iron-bearing belt of Gunflint lake and Vermilion lake, and of the Mesabi range.

6. The slates and shists which the Canadian geologists particularly designate Huronian.

7. The syenytes, granytes and other rocks that have been classed

8. The igneous rocks, known as the Cupriferous Series.

The particular and local details of stratigraphy and lithology will be given in the final report, with many interesting descriptions of scenic geology. A few general statements, which seem to be warranted by the observations of the past season, will be added here respecting the foregoing formations, though liable to modifications by later examination.

While No. 1 is in contact with the cupriferous rocks, and interbedded with them, at Duluth and many miles northeastward, No. 2 is in contact with them at Baptism river, No. 3 at Grand Portage, and No. 4 on Pigeon Point. The formations Nos. 2 and 3 (or 2 only, in the absence of 3) lie probably unconformably on No. 4, and being generally soft compared with the others, have permitted the excavation of bays, such as Pigeon Bay, Wauswaugoning Bay, Grand Portage Bay, Deronda Bay, Cannon-ball Bay, Double Bay, Horse-shoe Bay, Good Harbor Bay, and the bay at Black Point; the points projecting eastwardly being the igneous dikes or overflows, or the harder parts of No. 4. West of Black Point the coast line is mainly on the strike of the lower parts of No. 1; and so to about Little Marais, where it begins to ascend in the beds of No. 1 to Baptism river, where the order is reversed by an outburst of the underlying Nos. 2 and 3 for a short distance, the hill-ranges inland here also approaching the coast. Still further west the coast is wholly occupied by No. 1, apparently with a zigzag crossing of the strike as the line of upheaval brought the hills nearer the coast or let them recede. The points and islands east of Grand Portage Bay are in No. 4, or the associated igneous rocks of No. 8.

Nos. 4, 5, 6 and 7 are probably all conformably arranged in succession, at least they have been so seen at places. Nos. 4 and 5 are closely associated, and perhaps the latter is but a local phase of the former, while Nos. 6 and 7 are as closely related, being conformably interbedded and stratified. No. 5 is conformable with No. 6 in the iron district along the southeastern side of Vermilion lake. There are evidences that the cupriferous beds, *i.e.* the trap rock that plays a great part in the geology of the entire region, once extended over parts of No. 6, and it now lies almost everywhere over No. 4. Indeed the quartzyte and slates of No. 4, with the overlying sheets of igneous rock, are the only rocks seen *in situ* between Pigeon Point and Gunflint lake. Along the north side of this lake No. 6 first appears in force on the boundary line. Where the quartzyte of Nos. 4 and 5 terminates, westwardly, the cupriferous series also terminates. It was only on some of the islands in Vermilion lake

that there were evidences of the former extension of the igneous rock over No. 6, in the second metamorphism of some of the talcose slates.

The hill-ranges in the northern part of the State, north of Lake Superior, are, in general, mono-clinals sloping toward the S. S. E. and having various dip. They are uniformly (so far as yet seen) capped with a great thickness of the cupriferous series, and are composed, at different points, of strata belonging to Nos. 1, 2, 3, and 4, but most conspicuously to No. 4. Their ranges are not direct and systematic, but there seems to be a great confusion of short mono-clinal uplifts, the fractures repeating themselves a great many times in the same formation. Thus a vast number of faults in the broken strata are produced, causing veins and mineral deposits, and furnishing a key to the mineral explorer in searching for valuable ores. The hills formed by these short mono-clinals present their perpendicular sides, formed by the breaking of the beds, toward the northwest, and their gradual slopes toward the lake. The outline of their summits, if viewed a little obliquely, is exactly expressed by the name that has been given them at one point near the shore of Lake Superior—Saw Teeth Mountains.

The Mesabi Heights, north of Lake Superior, are composed outwardly of drift materials—at least wherever they were examined—and the ridge seems to be a glacial moraine. It is probable that its position was determined, at least modified, by the prior existence of a rock barrier through some of its course, if not through the whole of it. Indeed toward the northeast, where it crosses the international boundary, the mono-clinal quartzyte hills and ranges are the principal features, and it is probable that the strike of the quartzyte formation (No. 4) which is the most enduring and at the same time the most conspicuous of the tilted formations above the Laurentian, roughly coincides with this moraine.

There is some evidence that the location of some of the important points of outflow of igneous matter was along the north and west of the coast, and not in the bed of Lake Superior. Some of the Canadian geologists, particularly Mr. Robert Bell, have supposed that the original volcanic crater, or escape-point of igneous matter, was in the valley of Lake Superior, and is now covered by its waters.* Whatever may be the evidence to that effect, there are also evidences of a movement of the trap toward Lake Superior. Large masses of feldspar rock, embraced in the trap, as boulders are embraced in the hardpan clay, have been carried from Carlton's peak, or from a range of hills south and west of it, toward th

*Geological survey of Canada. Report of 1872-73, p. 105.

east and southeast. These embraced pieces become smaller in going from their place of origin, in the same manner as fragments of rock acted on by the drift forces.

In regard to the mineralogy and lithology of the State north of Lake Superior, many interesting observations and collections have been made, but it would not be profitable nor possible to effect their elucidation till they have been studied and classified, and until full data have been gathered for their discussion.

(b) Economic Geology.

Preliminary field-report of mining and mining locations.

Of the foregoing formations, as No. 8, is known as the cupriferous series, or copper-bearing rocks, so No. 6 might be conveniently designated the auriferous, No. 5 the ferriferous, No. 4 the argentiferous. The cupriferous rocks i. e. the trap, overlies unconformably Nos. 4, 5, and 6, and is interstratified with Nos. 1, 2, and 3. It becomes specially cupriferous in contact with Nos. 1, 2, and 3. Not an instance is known of its bearing metallic copper when overlying Nos. 4, 5, and 6, within the limits of Minnesota.

COPPER.

This occurs in the cupriferous series in several forms, but particularly as native metal. This has been reported for several years, and some systematic attempts were made in 1863 and 1864, by the French River Mining Company,* to carry on mining for copper at French river, but for some reason the working ceased in 1864, and has not been resumed again. Metallic copper here occurs in a mineral that seems to run in irregular veins and crevices in the trap, and consists of grayish-green, or gray massive prehnite, resembling a granular quartzyte. Pebbles of this mineral are frequently picked up on the beach, all the way from two miles east of Lester river to French river, and often show small deposits of native copper. This fact rather indicates that it occurs more or less in the trap of the region, weathering out as the trap goes to pieces. At this place all the surface indications and the associated minerals are favorable for the existence of copper in large quantities in the rock of the region, which extends several miles along the shore.

There are a number of other unimportant openings for metallic copper. Some were made by John Mallmann near Duluth, and here is in heavy beds dipping n. 10° w., and has slicken-sided

*A full account of these operations may be seen in the collections of the Minnesota Historical Society for 1867, by Hon. H. M. Rice.

others near Beaver Bay, and Grand Marais. Of the latter, that of Johnson and Maguire is characteristic of the manner of occurrence of metallic copper in the trap of the region. This is situated on Fall river, and the working, done in the summer of 1876, is in the valley near the water, nw¼ Sec. 24, T. 61n. R. 1w. The greenstone seams, or thin fillings between the layers. These seams contain what appears to be prochorite, with stilbite and small quantities of calcite closely intermixed. Some of these seams are half an inch thick. The copper, however, does not occur in the seams or veins, but in the massive, hard greenstone, in thin spangling sheets, once or twice the thickness of paper, or even a quarter of an inch thick, which sometimes extend over two or three square inches, though in general they are smaller than that.

As an ore, copper has been sought by shafting near the centre of Sec. 16, T. 60, R. 2w., about three miles west of the mouth of Cascade river. Here is a series of veins, or a loose network, running in various directions, but in the main w. 19° n. This can be seen on the shore, and also under the water of the lake for some distance. Some veins are from one to two inches wide, and others nearly six, the aggregate being about four feet. This is embraced in a bedded trap, which is frequently veined, and parts with the "heulandite" coatings, so named by Norwood. It crumbles, on weathering, to a coarse gravel of a dirty green color. It has also hæmatitic red spots on the weathered surface. Lumps of ore, styled "gray copper ore," have been taken out of this location, indicating a vein from two to four inches wide, associated with much laumontite, and calcite and stilbite. The rock also contains what appears to be thomsonite. The shaft that has been sunk was filled with water when visited, and no examination below about ten feet, could be made. Similar veins carrying "gray copper," cross Pigeon Point peninsula, and appear on some of the islands south of the mainland. These are owned by James Caldwell and others, and but very little examination has been made, calculated to test their value.

SILVER.

The great argentiferous formation, or gray quartzyte (No. 4), enters the State from the British Possessions with a width, along the boundary line, extending from the Lake Superior shore to the west end of Gunflint lake. There have been a great many mining locations made in the area of this belt of rock, the greater number by far being for silver. The silver occurs in veins, or leads, generally of quartz with varying quantities of calcite, fluorite and barite.

In some of these veins is a curious gangue-rock of brecciated quartzyte firmly cemented by the minerals that accompany the vein; and in this case the veins are themselves largely made of this breccia, and differ less in outward characters from the quartzyte formation in which they occur. They are sometimes twenty or more feet in width. These veins, or leads, of mineral-bearing quartz occur when the formation has been fractured; and as the whole country consists of a succession of sharp mono-clinals in this rock, the veins are found to lie alongside of the broken off layers, following the faults that now are in the valleys. Hence they are frequently overlooked, being hid by the fallen debris or by the scanty foreign drift. Occasionally a fault is apparent in higher levels, and such veins have been first discovered and "claimed." In general they have an east-and-west course, except when some irregularity of direction accompanied the uplift. The silver of these veins is in the form of argentiferous galenite and as native silver, and some very rich deposits have been discovered.

In Minnesota, less mining has been done in this formation than in British territory, not because of less favorable indications, but because of the greater ease in making permanent claims and securing titles to land under Canadian laws than under those of the United States.

In the following account, some of the principal mining locations visited the past season are mentioned. There are a great many other veins, and also some other mining works, that the writer has not seen, because they are less accessible, or were unknown at the time the field-work was going on, and the plan for the time being did not admit of visiting them.

A wide vein of calcite and quartz, the latter being sometimes amethystine, occurs on the sw¼ Sec. 32, T. 64, R. 7 e. This location is now owned by Caldwell, Dunn, Lightbody, Farrel & Wakelin. The vein runs N. & S., and in 1874 was worked by A. A. Parker, who made several shallow openings, (6 to 10 feet) on it. It underlies toward the west superficially, and passes between joints in the quartzyte (which in spots is argillacious and slaty) having a width varying from one to five feet. It also embraces pieces of quartzyte. This vein is said to carry argentiferous galena, but very little could be seen in the pieces thrown out. The working, however, has not been adequate to properly test the character of the vein.

West of the foregoing about twenty rods, is another vein showing about a foot wide, thought to be a branch from the former. In this vein, on which no working has been done, croppings show heavy spar, calcite, carbonate of copper, and amethystine quartz, the bulk being heavy spar; runs N. 20° W.

About an equal distance east of the main (N. and S.) vein, is another vein, which shows about eight inches in width near the water level, but becomes indistinct, with included black quartzyte, and widens to two or three feet a rod or two from the coast. It sometimes appears wholly involved or lost in the formation, without calcite. This has not been worked, and is owned by the same parties. These three are thought to be parts of the same vein, and they probably are. Their direction is not in harmony with the direction of most of the veins examined further from Lake Superior, being rather transverse to the prevailing direction of the system of faults so conspicuous in the quartzyte, than coincident with it.

The last vein mentioned above seems to pass under the water southward, and to reappear on the south side of Susie Island, where several similar veins, five in number, can be seen, running in about the same direction. The most of these show no spar, but generally only a dark gangue-rock resembling a basaltic quartzyte, or a quartz breccia. That, however, which is supposed to be a continuation of another from the main land is three feet wide, and shows heavy spar near the water, and contains copper ore in the form of bornite and chalcopyrite, and also (argentiferous) galena.

About ¼ mile west of the last is a fine spar vein running in the direction of the island, nearly east and west, visible under the water near the shore eight inches wide and extending about 25 feet. It pinches out in both directions.

Baker and Kindred's location on Pigeon Point is about three-quarters of a mile east of the point that encloses Clark's bay, near the south shore of the peninsula. Here a shaft was sunk in the winter of 1877–8 by Mr. McPherson for the owners, but on striking water in about twenty feet, and being without facilities for pumping, the work was not then prosecuted further, and has not been resumed since. The shaft was sunk where two large veins cross each other, one of these veins *(a)* is 9 to 10 feet wide, runs east 15° south and the other *(b)* is 5 feet wide and runs south 10° east. Vein *(a)* is discontinued at the shaft, or continues a few feet as a closely jointed irony rock which was probably once charged with pyrites, and then is lost in the country rock; but a natural trench marks its course for several rods further west. It may reappear further on, but though the surface had been lately burned over, consuming even the vegetable mold of which the soil principally consists, no spar could be seen. The shaft principally discloses this vein, but is located a little too far east to show the contents of vein *(b)*. The minerals thrown out are calcite, barite an amethyst, with the ores pyrite, sphalerite, galenite and chalcop

These are visible. Others might be seen on having more favorable opportunities. No ore of any kind lies about the shaft, but small crystals and masses of these ores are scattered in the spar. There is also considerable pyrite and chalcopyrite connected with the lenticular masses, or "horses," of compact, hard, geenish rock that are enclosed in the spar. Vein *(b)* can be traced by the protruding spar (barite) a few rods beyond the shaft, but then is lost to sight. The spar of vein *(b)* is more firm than that of *(a)*, and more siliceous. It also embraces a different rock in irregular masses. There is a similar trench extending beyond the shaft in the direction of this vein, and even across the axis of the peninsula, though this is interrupted. Two similar heavy spar veins appear on the coast on the opposite side of the peninsula in Pigeon bay, which are without much doubt in the extension of these veins, though their direction is not exactly the same.

The tests that have been made of these heavy spar veins have been insufficient, and especially so by the fact that the shaft sunk by the owners did not open vein *(b)* at all.

The *White Rose* vein, known also as the Kindred vein, is about 1¼ miles north of the international boundary, at the east end of the first lake west of Mountain lake. On this have been sunk several shafts. Kindred's shaft is 37 feet deep, and the gangue minerals are calcite and quartz, the greater portion being calcite. These are mixed in irregular small veins and meshes through the quartzyte and slate of the country; the "vein" consisting of a brecciated and re-cemented fracture through the formation, and the cement being the minerals above, accompanied by galenite, native silver and pyrite. There is also in the calcite alongside of the blacker parts of the slate a copper-colored mineral in small hexagonal plates. It is brittle, and is said to fuse easily to a brittle globule. The best assay from this shaft is said to have got $1,100 per ton, but the ore has not been assayed by the survey.

Baker's shaft, which is on the same lead, about half a mile further west, is 26 feet deep. The vein here is conspicuously exposed on the face of a low bluff, facing SW. and is about 9 feet wide, with a "pay streak" increasing from six inches at the top to about 2½ft. at the bottom. The shaft goes partly in the slate, and then crosses the vein, which "hades" to the northeast. There is trap on the north side and slate on the south side, and trap rock is somewhat mixed with the vein also. The same minerals appear here as already named for the Kindred shaft. The best assay is said to have given $272 per ton; $16.60 per ton being got from poor quartz on

the north side of the vein, in which no ore could be seen with the naked eye.

The vein itself goes generally along the line of contact of slate (south side) with trap, but sometimes is wholly within the slate, and sometimes partly within the trap. The fracture, which seems to have been of the date of some subsequent igneous upheaval (as shown by the veined condition of the trap of the country), branched off, and also went somewhat zigzag in some places. It crosses Arrow lake, and can be seen on the other side as a conspicuous white belt on the bluffs, on that side crossing the slate and trap. In some places it is mostly of quartz, and there stands out above the surface.

On this vein are different parties located somewhat in the following order viz:

(a) West of the Kindred Brothers' location.

1. J. H. Baker, associated with Munger, Swan and others.
2. An eastern company.
3. Stewart, Sabin, Graves, Herman, Markell, Burg, Lightbody and Caldwell.
4. Geo. C. Stone & Co., Johnson, McKinley & McGuire.

Dr. Smith and —— Egan are also interested in some of these locations.

(b) East of the Kindred Brothers' location.

1. Hamilton, Sabin.
2. Dr. Stewart, McPherson.
3. Markell.
4. Col. Graves, Van Brunt.
5. Lightbody.
6. Caldwell.

William P. Spalding has a mining location on the south side of lake Miranda, which is a narrow long lake next north of lake Fanny, and on Sec. 5, T. 64, 2 E. This vein is strong, but not well defined. His work consists of several shallow pits for the purpose of ascertaining more definitely the position, direction and dip of the vein. What can be seen of it consists largely of breccia of trap, or of quartzyte recemented with quartz, in small, often drusy crystals. It is six or eight feet wide, and occurs, like others, along the north side of a quartzyte mono-clinal, and is largely hid by the talus materials. Mr. Spalding says he has taken out several pieces of native silver, but none was seen in the fragments thrown out.

On the other slope of this mono-clinal, south of the ab another fracture, which seems likewise to have taken the

a vein. Some working on this slope disclosed the existence of the fracture, and large float pieces of vein material indicate the contents, but the work had not gone far enough to precisely define its location and extent.

Mr. Spalding's "Ancient Diggings," so-called, consist of a series of depressions running along the supposed position of the first vein above mentioned, so as to make in some places a continuous trench. In some parts there are two ridges, with an irregular depression between them somewhat semi-lunar so that it unites again with the main depression. One of these ridges, that nearest lake Miranda, consists of clay and angular pieces of quartzyte; like talus *debris*, largely decomposed, but the other is of angular blocks, and Mr. Spalding says contains vein material, as if thrown out of the depression in excavating on the vein. These depressions show some openings within, between large boulders, and nearly large enough to admit a man, and after clearing out a little one was followed downward some feet. As yet no ancient hammers or implements of any kind have been found in the vicinity.

As to the cause of the depressions and parallel ridges, there may be three different explanations. Sufficient data are not at hand for affirming either.

First. They may be due to ancient mining, as supposed by the owner, though the non-discovery of hammers is necessary for the demonstration of this hypothesis. It is also true that the ancient mining hitherto discovered in the Lake Superior regions has been wholly for native copper, of which implements have been found in ancient works as far south as the state of Georgia, but so far as known, no silver implements have been found having so old a date; and the ancients seem to have had no knowledge of any process for reducing the ores, the silver in this formation occurring mainly as argentiferous galena.

Second—The depressions may be due to the solution and removal of the contents of a large vein under natural processes, and the consequent settling of the surface. When two depressions run nearly parallel in that case, the vein may branch out and become double, uniting again when the depressions unite. Then, also, the upper ridge, neared the bluff, would naturally contain coarser peices than that nearer the lake, which is true. Veins are thus dissolved sometimes, and sunken in for some distance, as the large baryta vein on Pigeon Point. This cause, if true, indicates a strong vein, and one that, with the quartz now remaining as the sole matter undissolved, must be charged with soluble minerals, and perhaps with very valuable ores. Deep shafting alone will deter-

mine it. So far as exposed, however, the quartz remaining now undissolved is sufficient to form a firm frame-work, capable of supporting the overlying materials so as to prevent such a collapse of the surface as here supposed.

Third—These ridges may be of the nature of ice ridges or moraines. There are a great many instances of ridges thrown up by the ice of lakes through alternate freezing and thawing both in Minnesota and Iowa, and sometimes such have received the name of "walled lakes." But aside from this, the ice of the last ice period may have lain for a long time prior to its final disappearing, in the rocky valleys of the northern part of the State, as suggested by Mr. John Lightbody. Its effect, along a rocky bluff, would be to form low, blind ridges of debris or morainic material. which would remain more or less distinct to the present under favorable conditions. In that case the coarser nature of the ridge nearer the bluff would be due to the fallen pieces from the bluff itself, while the clay of the ridge nearer the lake may have been due to drainage in that direction and to the crushing action of the ice in times of expansion. The level of the ice would remain nearly constant under the same causes which now keep the level of the water nearly constant.

These considerations are here mentioned, as there seems to be a tendency at other places in the northern part of the State to attribute such phenomena to ancient mining, perhaps without sufficient reason.

John McFarland's location is on Secs. 9 and 10 T. 64 N. R. 3 E. He has two veins, and one place thought to be a site of ancient mining, in all respects similar to that of Mr. Spalding, except that this series of ridges and depressions is not near any lake at present, but alongside a bluff enclosed in a valley. If a vein should be discovered at this locality, then Mr. McFarland has three distinct veins situated on different sides of a monó-chinal hill, viz.: one on the north side, one on the south side and one on the east side, the last being that in which are the supposed ancient diggings. These are all close together, and the east and west veins are all well marked, running also across the adjoining valleys and appearing in the next hills. They are outwardly of quartz and brecciated quartzyte, and occupy faults between the slate and the trap of the country. Mr. McFarland has done no work on his veins, but is occupied in farming and fur-catching.

Johnson's working is on a vein situated, as nearly as could be ascertained, on SE ¼, Sec. 32, T. 65, 3 E. This is also on the slope of a hill, but has trap on the north side and sla

south side, being really in a fault like the rest ; but the slate is here brought up like the south vein at Spalding's, on a line nearly parallel with the upper surface of the trap. This vein shows mainly calcite, but has also quartz pyrite, galenite, and native silver. These can be seen in the dump near the shaft. There is also, as in nearly all the other veins seen, a large amount of brecciated quartzyte and siliceous slate. This is here mainly on the south side of the vein, while the north side is in a similar manner filled with breccia of trap. This appears to be a strong vein, and one that promises well.

McFarland, Rice and Ramsey have a very conspicuous and strong vein near the shore of Pine Lake, on S. E. quarter sec. 31, T. 65 N., R. 1 E. This has not been worked, but slightly uncovered in two places. It has an irregular direction, width and appearance, large white masses of calcite and quartz lying about promiscuously, apparently in place, over a width of several rods north and south. Where it has been uncovered it is also mixed with a breccia of quartzyte, and has a width of ten or twelve feet. It seems to have trap on the north side, but it is not well exposed. A trap bluff rises abruptly toward the northwest, facing east and south, and the vein is in a lower level, having a zigzag course, governed, apparently, in direction and deflected by that upheaved trap and slate along its western extent, so far as it is visible; but further east it has a more uniform course in consonance with the general trend of the hills, yet this, like Spalding's second and one of McFarland's, is on the southward slope of the main hillside. The calcite and quartz, not mentioning the breccia, are the most abundant gangue-rock. The ores are pyrites (said to be auriferous) galenite, sphalerite and chalcopyrite. These, with the exception of the galenite, can be made out in examining the pieces in the dump. This seems to be as strong and promising a vein as the White Rose, near Arrow Lake.

IRON.

The gray quartzyte and slate, which is particularly known as the silver-bearing formation, and contains the foregoing silver veins and mining works, graduates below into a siliceous iron-charged rock, which in some places furnishes a valuable iron ore in large quantities. The silica is often colored so as to make jasper, flint, chalcedony, and other parti-colored pebbles when the formation disintegrates. These gave name to Gunflint Lake, on the international boundary, the beach of which is strewn with them. There are also "dolomitic" bands, and these sometimes contain angular pieces of jasper and flint, associated with the same beds in some

manner not yet made out. What may be the thickness of this bed of iron ore rocks has not been ascertained. They seem to be conformable both with the overlying quartzyte, and with the underlying schists and slates, but this may not generally be the case. There are various places at which this belt of iron ore is known, but the most important is that known as the "Mesabi Iron Range," situated in towns 59 and 60 N. of range 14 W. The range itself probably extends a great many miles, maintaining its ferriferous character, and covers other known locations. Some working has been done also back of Grand Marais, and some near Vermillion Lake.

The iron in towns 59 and 60, range 14, has attracted the most attention, probably because of a costly exploration made there a few years since by parties from Pottsville, Penn. The ownership of the locations that were examined becoming involved in litigation nothing practical has resulted publicly from the examinations. The information obtained belongs to private parties. Samples of this ore are being examined chemically by the survey. According to published analyses the ore varies in metallic iron from 61 to 66 per cent., being mainly in the form of magnetic oxide. Its chief impurity is silica, from 5 to 10 per cent. It has from 2 to 3 per cent. of lime, and from a half of 1 per cent. to 1½ per cent. of magnesia. Manganese oxide varies from about one-half of 1 per cent. to 1.3 per cent. No sulphur has been detected in it, and but a trace (less than one-fourth of 1 per cent.) of phosphoric acid. Alumina varies from one-fourth of 1 per cent. to over one-half of 1 per cent.

The following is an analysis by Prof. Campbell, of the School of Mines, of New York:

Magnetic oxide of iron	86.869
Oxide of manganese	1.313
Silica	9.980
Lime	2.046
Magnesia	1.299
Alumina	.633
Total	102.138

The following was made by Prof. E. R. Taylor, of the Cleveland Laboratory of Analytical Chemistry, Cleveland, O.:

Insoluble siliceous matter	4.06
Iron as metal	65.62
Iron protoxide	23.34
Sulphuric acid	None.
Phosphoric acid	.18
Lime	3.15
Magnesia	.50
Manganese oxide	.64
Alumina	.35
Total	97.84

The ore resembles those of Scandinavia and Russia, as well as the magnetic ores of northern Michigan, and the geological age is the same, in general terms. For making steel these ores excel, and iron from the Scandinavian furnaces is imported into England for the manufacture of steel. It is highly probable that these iron deposits will not lie long undeveloped. They are in the midst of hardwood timber sufficient for producing the necessary charcoal, and the surrounding country is generally fit for prosperous farming. They are easily accessible by the construction of roads either from Thomson, Duluth or Beaver Bay. From Thomson the distance is about 65 miles, from Duluth due north about 55 miles, and from Beaver Bay about 45 miles.

GOLD.

The region of Vermilion Lake has been known for some years as a gold-bearing region. This was fully brought out by the reports of H. H. Eames in 1866. At that time a flush of feverish excitement led to the expenditure of considerable money in sinking shafts and erecting works for mining. Three steam stamp mills were erected, another running by water power. One was owned by the New York Mining Company, whose location was near the "Mission" on the south shore, another by Nobles & Company, further northwest, and another by Seymour & Company. The water power mill was owned by the Wabasha Company, and was located about two miles from Vermilion Lake, at Trout Lake. Eight or ten mining companies were at work simultaneously in different parts, mainly on the southern shores, or on islands. A town site was laid out at the southern extremity of the Lake, several large buildings put up, and stated communication made with Duluth. The village was named Winston. Above the village, at Pickerel Falls, a lum-

ber mill was projected, and the foundations laid. These things have all passed away. There is not a building at Winston. Two of the steam boilers were hauled back to Duluth, where they are still in use; the mills have been burnt, as well as most of the buildings put up by the mining companies. the shafts, generally filled with water, are abandoned, and there is but a single white man (a government officer) to be found in the whole district.

The gold occurs with pyrites, some of which appears to be cupriferous. This pyrites is found in milky white quartz which accompanies the joints of the rock, and also is disseminated through the rock itself. The most of the working was done on quartz deposits, but that of Nobles & Company embraced also a large amount of the rock itself. The rock of the region is of the Huronian age, and follows immediately below the ferriferous formation last described. It is mainly a talcose slate, but varies to an argillaceous talcose slate and to a talcose quartzyte. It also passes into what may be styled provisionally a syenite. The schistose structure runs a little north of west, and stands almost perpendicular. Samples of this quartz ore yielded on an average about twenty-five dollars per ton, according to assays reported by Mr. Eames. Samples of the ores of this region have been collected by the survey, as well as of all other mining locations mentioned, and in time thep will receive analysis and further report.

THE NEEDS OF THE NORTH SHORE.

First—During the season all parties connected with the survey have had occasion to note the frequent and wanton destruction of the native forests by fire which rages annually and destructively. There is nothing so utterly ruined and desolate as a country lately burnt over. The soil itself, consisting very largely of vegetable mold, is burnt to considerable depth, or quite to the rock. Thousands of acres of the finest forest timber, including large pine trees, are thus destroyed every year. It is estimated that annually ten times as much pine is thus destroyed in the State as is cut by all the mills. A large part of the triangle north of Lake Superior has thus been devastated. Some sheltered tracts have escaped. The State has lost in this way more than as much pine as now remains, and will at no very distant day awake to the fact of having lost by neglect, and willful or careless destruction, one of her chief resources. These fires are set generally by travelers or explorers. The Indians remonstrate, and are generally careful about their camp-fires in the dry season, well knowing the effect fire the game that furnishes their chief sustenance.

The scattered white inhabitants are too few to effect anything in stopping these fires, except in the preservation of their immediate surroundings, and they also complain that the country is thus being rapidly desolated. It rests with the State Legislature to take some action to punish those who wantonly or carelessly set the forests on fire, similar to that to punish those who fire the prairies. If concerted action were taken by the State and the Canadian authorities it would be more effectual, since fires originate on both sides of the boundary line.

Second—There should be some improved harbor on the north shore for refuge for vessels in time of storms, although there may not be commerce to demand it at any one locality. At the present time there is no lighted harbor for vessels between Duluth and Thunder Bay in Canadian Territory, and between these points there is a great deal of travel. The establishment of a single good harbor would at once attract travel, trade and settlement, and would tend to the development of some of the mineral interests that now lie dormant largely because so inaccessible.

Third—There is a wrong opinion prevalent regarding the agricultural character of the northeastern part of the State. It is pronounced by some who have not seen it, as mountainous, sterile and untillable. These terms apply to but a small portion of it, viz.: a belt from one to four miles wide along the shore of Lake Superior, and a tract of unknown area in the extreme northeastern corner, and along the boundary line westward to Vermilion Lake and the west end of Hunter's Island. In these parts the rock of the country is perhaps the most conspicuous feature. But south of the Mesabi range, and particularly in the St. Louis valley, the country is generally flat, the streams are slow and broad, the soil a loam or a sandy loam, or a stony clay, and equal in all respects, except in being farther north, to thousands of acres that have been cleared and converted into valuable farms in the states of Michigan and Wisconsin. When it is remembered that more than a hundred miles further north, in Canada, railroads, canals and settlement are rapidly being introduced, and that still further north and west, beyond the ameliorating action of the water of Lake Superior, is thought to be one of the great wheat fields of the Continent, it is plain that there is nothing to prevent the final occupancy and development of northeastern Minnesota as an agricultural district.

III.

FIELD REPORT OF C. W. HALL.

Prof. N. H. Winchell, State Geologist:

SIR—In accordance with the plan arranged by you for the prosecution of the State Geological Survey during the past autumn, the Lake Superior section of the geological corps reached Grand Marais August 30. The work of this section was to be the exploration, so far as practicable, of the rivers emptying into Lake Superior, from the lake shore to their headwaters; and the ascent of some of the more prominent peaks of that continuons chain of low mountains skirting the northeast shore. The chief object of this work was to trace out the rock formations, so far as the river beds and the bluffs would show them, and to articulate the same upon those already traced along the coast of the lake during the summer months; or to indicate the direction of the latter as they extend onward into the interior of the State.

As a canoe and provisions for the expeditions to be made from Grand Marais along the lake shore and into the interior had to be procured, and an Indian hired to serve as a packer and guide, one or two days time was consumed in preparation. And then, after all was ready, the condition of the lake prevented our starting. While waiting for heavy northwest winds to subside the hill back of Grand Marais was ascended, its hight measured and search made for out-crops of rock that would give some clue to the lithological character of the elevation. In measuring the height accurate results were not expected, since one series of observations made with an Aneroid barometer, and extending through a whole day can be no more than an approximation to accuracy. The height of the hill as determined was 775 feet. Two or three interesting exposures of igneous rocks were found, evidently as broad dikes or overflows, and some water from a "caribou lick" on the south side of the hill, was collected.

After a rainy and rough passage we reached Indian River the seventh of September. An examination of this stream, which forms a part of the boundary between the Grand Portage Indian Reservation and the unsurveyed lands lying in the northwestern part of the State, was to be our first work. The river is so rapid throughout its entire length that there is no canoeing until the lakes in which it has its source are reached, and there is not even a fisherman's trail along its banks. Fortunately in the upper part of its course the stream through a more level country, intersected by numerous caribou trails;

it would have been almost impossible for the packers to have made their way. When there were no trails to follow not more than three or four miles could be made in a day. In this heavily wooded country of the Lake Superior region the dense undergrowth and the windfalls are much greater obstructions along the river courses than away from them. When on the height of land to the east of the the river, we struck the sugar bush of the Grand Portage Indians, and followed their trail along the ridge to Grand Portage. At this place an Indian was hired to take the party to their late camp in his canoe.

A thick stratum of drift overlies nearly the whole region drained by the Indian river. Along its course are many banks of that red drift clay so frequently met with in the northeastern part of the State.

The next expedition was up the small stream called by Dr. Norwood in Owens' report, Flute Reed river. Being nearly out of provisions one of the men, a half-breed Indian named Antoine, was sent to Grand Marais for fresh supplies, while the remaining two made a two days' trip up the river. The progress made here was quite satisfactory since the timber for nearly the whole distance traveled had been burned only two seasons before. Antoine was taken sick at Grand Marais and was unable to return. As Mr. Mayhew sent another in his stead but little loss ot time was occasioned thereby.

A creek emptying into the lake in the S. E. ¼ Sec. 2, T. 61, R. 2, E. 4th Mer. shows some very beautiful features. The gorge which the water has worn through the jointed shaly rock is one of the grandest of the many grand works of nature between Duluth and Pigeon Point. Its depth often exceeds one hundred feet and the walls are occasionally so near—in two or three places from four to eight feet—that fallen trees form foot bridges from one side of the stream to the other. Several domes seventy-five or eighty feet high are worn in the walls. The bottom of the gorge is dark and gloomy for the sunlight never enters except here and there in straggling rays. Toward the headwaters of this stream and overlooking a beautiful lake is the sugar bush of Timote Sunamo. At a distance it looked as if outcrops of rock could be found there. A day was spent in making an excursion to the place. The summit of the hill by the old sugar camp was 1,240 feet above Lake Superior. No rock was found except drift boulders and these occurred to the very summit.

Kimball's creek came next in order for examination. Owing to the character of the rock—it was identical with that found along the stream last visited—and the shortness and smallness of the stream, only one day was devoted to the work.

Thus having made a hasty examination of nearly all the streams from Pigeon Point to the Brule river we started for Grand Marais that we might there make preparations for the ascent and examination of that stream. This would necessitate an expedition of at least four week's duration into the interior. But a severe storm, which made the trip to Grand Marais in our canoe a somewhat dangerous one, continued with drenching rains for more than a week. When the weather was again fair, not only had much valuable time passed by, but the river was rushing down to the lake in a torrent and the swamps were full and almost impassable. Accordingly it was thought best to abandon the idea of ascending the Brule the present season, and, instead, examine some of the smaller, shorter streams and a country freer from swamps. Rosebush river, a small stream in whose bed, one and one-half miles from the lake shore, is an abandoned copper mine* receceived a second visit, the first having been made in

*This mine lies in the N. E. ¼ of N. W. ¼, Sec. 24, T. 61, R. 1 W.

the summer by the State Geologist and his party accompanied by Professor Peckham and Mr. H. Mayhew.

Good Harbor Bay also received a call. This is one of the most interesting localities for the student of geology that the whole Northwest shore affords. Around the point to the west of the bay occur the beautiful thomsonites thickly studding the upper strata of a bed of apparently igneous rock; while along the shore of the bay a bed one hundred or more feet in thickness of nearly horizontal sandstone lies sandwiched in between the thomsonite-bearing rock just mentioned and another igneous rock underneath. Many minerals occur in the several beds for the most part in a concretionary form. The distance of this locality from Grand Marvis is only five or six miles.

The last expedition made from Grand Marais during the season was for an examination of the shore line some miles to the eastward of that place and the ascent of the Devil's Track River to the head of Devil's Lake. As a preliminary step our canvas canoe and a supply of provisions were packed into the interior to a point on the river about two miles below the foot of the lake. We started from Grand Marais on the eighteenth of October. Although the results attained along the coast were all that could be desired the expedition as a whole was not entirely satisfactory. The water in the river was so high that the ascent could be made only by following along the summit of the bluffs. On Devil's Lake our canvas canoe was used for the first time. It was found harder to row and at the same time not so swift as a birch bark canoe. But the fact that it is light and can be folded and packed through almost any part of the forest renders it peculiarly adapted to our work. The canoe we had was hastily made and delivered to us in a very unsatisfactory condition, and much time and labor were required to make it in the least serviceable; still that is no argument against a light, strong and *well made* canoe. Having finished our work on the morning of Friday, the twenty-fifth day of October, in the midst of a blinding snow storm, we struck camp and started for Grand Marais. We had gone scarcely more than two miles before we were met by a messenger sent by Mr. Mayhew announcing the glad news that on the following day the schooner *Beaver Bay Charley* would touch at Grand Marais on her way from Grand Portage to the head of the lake. This word hastened our steps; we reached the lake, placed everything in readiness, but the vessel never came; only the dreary prospect lay before us of a voyage in an open boat over the more than one hundred miles stretching between us and Duluth. The task was undertaken and ended after five days exposure to cold and danger—for it was the week of disasters on the lakes—by our being taken up at Beaver Bay by the tug Nellie Cotton and brought to Duluth, which place we reached November 2d.

In giving this account of the work done, it cannot be out of place to mention the obligations of the party to the Mayhew brothers and Mr. Howenstein, of Grand Marais, for favors shown on every occasion. Messrs. Mayhew placed a building at our disposal, in which to lodge whenever we were in the place, and all spared no pains, and suffered no opportunity to pass by, for rendering assistance, particularly in giving knowledge of the country which was the field of our explorations.

Although a whole season has now been given to the examination of the Lake Superior region, as yet the work is hardly begun. I would suggest that all the time possible from the limited amount at the disposal of the survey, be given to this part of the State. Facts may be here gleaned that will have great weig in the determination of certain scientific questions of universal interest.]

viction becomes stronger, as the survey progresses, that the geological structure of this part of the State is more simple than has generally been supposed. Many theories have been pronounced without sufficient foundation of fact, and their multiplicity serves only to confuse him who would through reading arrive at a a clear understanding of the lithological and historical characters of the Lake Superior rocks.

Respectfully submitted,

C. W. HALL.

IV.

ELEVATIONS ON THE MINNESOTA NORTHERN RAILROAD.

By J. B. CLOUGH, Chief Engineer.

Line of the Pelican River Valley.

NAME OF PLACE.	Township.	Range.	Section.	Distance from Fergus Falls.	Elevation above the sea.
Summit	133	43	10	4	1261
Height of land ⅓ mile east summit	133	43	10	4	1320
First crossing Pelican River	134	43	29	9	1222
Second crossing Pelican River	134	43	20	10	1226
Third crossing Pelican River	134	43	20	10¼	1233
Fourth crossing Pelican River	135	43	4	20	1277
Pelican River below dam at Pelican Rapids	136	43	27	22	1292
Pelican River above dam at Pelican Rapids	136	43	27	22	1302

V.

CHEMISTRY.

REPORT OF PROF. PECKHAM.

Prof. N. H. Winchell:

MY DEAR SIR:—In conformity with the instructions of the executive committee* of the Board of Regents, I have the honor to report regarding my trip to Lake Superior as follows:

*See Appendix A.

I was instructed to advertise the intended action of the Board in sending me there in Duluth and St. Paul. This advertising was done, and from all that I could learn all persons likely to be insterested were well informed in regard to the matter.

I was also instructed that "any parties who will make affidavit that they are citizens of Minnesota, and that the ores are found in Minnesota, giving the localities where the ores were found as nearly as possible, and certifying their willingness that the results may be published, shall be charged one-half the * * prices."

"Payment for assays may be made in specimens of minerals or ores, at Prof. Peckham's valuation."

These instructions were also well advertised on the north shore, but no assays were offered subject to these conditions. No ores or minerals were therefore received in part compensation for assay work.

When not employed in assaying, I made collections of minerals in the neighborhood and on the coast above and below Grand Marais. Some of these specimens are large, in fact too large for exchange, and were gathered with the expectation that you might want them for the General Museum.

I also obtained by private purchase a quantity of zeolite pebbles, that on examination present some features of interest. I have thought that possibly you might desire a chemical examination for the survey, and I have therefore delayed a thorough examination until I could lay the matter before you.

These specimens are of considerable value, and I found that the only way in which I could secure a suite for our cabinet and prevent them from going out of the State, was to purchase the whole lot.

The specimens to which I have referred above as having been collected with a view to being placed in the General Museum have been opened, and are now awaiting your inspection at the Agricultural Building. I trust that you will make it convenient to look them over soon, as they are getting dusty.

An early decision in reference to the examination of the minerals purchased, will oblige,

Very truly yours,

S. F. PECKHAM

MINNEAPOLIS, Nov. 11th, 1878.

The following results have been obtained for serial numbers 55, 56 and 57. They were all three limestones. They were dissolved in dilute hydrochloric acid and boiled. The portion remaining insoluble was estimated as "insoluble." The iron, etc., lime, magnesium, carbonic and sulphuric acids, were then estimated in the usual manner. The results were as follows:

	55	56	57
Insoluble	24.21	16.22	2.82
Ferric and aluminic oxides, $F_2O_3 + Al_2O_3$	3.32	1.14	1.39
Calcium Sulphate, Ca So_4	4.32	.73	6.74
Calcium Carbonate, Ca Co_3	47.11	54.28	52.22
Magnesium Carbonate, Mg Co_3	20.76	27.48	36.04
	99.72	99.85	99.21

The very small percentage of alkalies amounting to but little more than a trace, was not determined.

No. 55 contained druzy cavities filled with pure white granular silica, which would cause the insoluble portion to vary in different pieces.

The insoluble portion of No. 56 containeed a large amount of iron in an insoluble form. No. 57 is a very pure magnesian limestone.

These three specimens are the only ones that I have received in time to complete their analysis.

S. F. PECKHAM.

MINNEAPOLIS, Jan. 30th, 1879.

VI.

ORINTHOLOGY.

REPORT OF DR. P. L. HATCH.

MINNEA

Prof. N. H. Winchell:

DEAR SIR—It is my pleasure to be able to report a
Ornithological section of the Natural History Survey o
just closed.

The distribution of resident species of birds, the
which most affect such distribution, and the interest
pied the attention of the survey largely. Personal v
ties in the best times for observation and the resta
amateurs, have greatly facilitated the accumulation of

Questions of profound interest to science have mul
settled by a thorough exploration of all sections of the
agricultural purposes, which it is hoped the present
afford new facts for their solution. The characteristic
are so varied that each must receive special observat
which compels me to depend much upon the princ
The "passes" on the Minneapolis, White Bear and D
much to my facilities during the past year. I think
could be afforded over the other lines of railroads p
hitherto unexplored by the Survey, results of surpassi
during the present year. My co-laborer and invalu
Herrick, has not enjoyed his usual opportunities for
year which I had hoped, on account of his time bein
partment of still greater importance to science. I sh
that he may be able to render greater service during t

I am very respect..., ...,

P. L.

VII.

BOTANY.

THE PLANTS OF THE NORTH SHORE OF LAKE SUPERIOR. BY B. JUNI.

The greater part of the forest of the north shore consists of evergreens, such as spruce, pine and cedar. Birch is nearly everywhere interspersed, and poplars are nearly as common. From French River northward the trees gradually decrease in size. Already at Grand Marais the difference is quite apparent. At Pigeon Point the trees seem to be but half grown. The same is true of altitude; on the ridge of Mount Josephine there is only a stunted growth of trees, which at its foot reach the ordinary size. This can hardly be due alone to the difference of moisture and soil. The abundance of mosses and lichens gives to the forest a character peculiar to northern latitudes. There is scarcely a rock or tree that is not partly or entirely covered by the different species. The ground is often covered by a layer nearly a foot in thickness, which conceals the angular fragments of rock beneath. In many places there is no soil except what is entangled in the mosses and lichens. This fact serves to make fires all the more destructive. They consume everything, to the very rock; nothing remains but the charred trunks of trees, many of which fall at the time, while others, whose roots struck into some deep crevice of the rock, stand a few years longer as monuments of the destructive folly of man. The next rain or wind carries away the last traces of soil, and leaves the rocks bare and calcined. Nature now sets about to cover again the surface by an other slow succession of lichens, shrubs and trees. The trees in proximity to the lake, and especially on the side facing it, are draped with a moss-like lichen (Usnea longissima?). This hangs in long tufts of about a foot and a half from trunk and branches. When dry it is as combustible as shavings or straw. It is by no means an unimportant article in this region. For packing specimens and for bedding, there is no better material. This lichen is found both upon live and dead trees, but more commonly upon some species than upon others. There are some wrong theories prevalent regarding it It neither injures a live tree nor has it any preference between a live and a dead one, as long as the bark to which it attaches itself remains upon the tree. Its nourishment is derived from the air and not from the tree upon which it lives.

Myriads of caterpillars have stripped the younger growth of deciduous trees of their foliage in a number of places this season.

Swarms of grasshoppers appear to have passed over these regions, but thousands happened to alight in the lake instead of on the land. In Grand Portage Bay great numbers of them were seen floating on the water still alive and eager to take passage on any floating object.

The resinous matter of the wood which falls into the streams, is said to impart to the water that dark amber color peculiar to all streams which enter upon the north shore.

About fifteen hundred specimens of plants have been collected and preserved, which represent, perhaps, one hundred and seventy-five species. More than that number have been identified, but it was not found convenient to preserve all specimens. The duplicates are intended for exchange. A full collection of Carices, to which special attention was given, was lost.

In considering the results it should be borne in mind that no expenses to the State have been incurred, which would not have been necessary without them. A few leisure hours were given to this work by one who did full duty in another line.

List of Plants of the North Shore of Lake Superior.

RANUNCULACEÆ.*

r Clematis Virginiana, *L.* Virgin's Bower.

Thalictrum Cornuti, *L.* Meadow Rue.

Ranunculus Cymbalaria, Seaside Crowfoot. Found only at Grand Portage.

Ranunculus Pennsylvanicus, *L.* Bristly Crowfoot.

c Caltha palustris, *L.* Marsh Marigold.

Aquilegia Canadensis, *L.* Wild Columbine. Very beautiful, flowering late in August.

Actaea spicata, *Var.* rubra, *Michx.* Red Baneberry.

NYMPHACEÆ.

Nuphar advena, *Smith.* Yellow Water Lily.

SARRACENIACEÆ.

Sarracenia purpurea, *L.* Pitcher-plant. Abundant in open marshes.

FUMARIACEÆ.

r Corydalis aurea, *Willd.*

r Corydalis glauca, *Pursh.* Burnt ridges.

**r* Signifies that the species is rare.
c Signifies that the species is common, and
vc Very common.

CRUCIFERÆ.

c Cardamine hirsuta, *L.* Bitter-cress.
Arabis perfoliata, *Lam.* Tower Mustard. Poplar River.
Arabis Drummondii, *Gray.* Castle Danger.
Barbarea vulgaris, *Michx.* Putin Bay. Common Winter Cress or Yellow Rocket.
Draba arabisans, *Michx.* Castle Danger.

DROSERACEÆ.

Drosera rotundifolia, *L.* Sundrew. *c.*
Drosera longifolia, *L.* Little Marais.

CARYOPHYLLACEÆ.

Stellaria media, *Smith.* Common Chickweed. Grand Portage.
Stellaria longipes, *Goldie.* Duluth.
Cerastiurm nutans, *Rap.* Mouse-ear Chickweed.

GERANIACEÆ.

Geranium Carolinianum. *L. c.*

BALSAMINACEÆ.

Impatiens fulva, *Nutt.* Spotted Touch-me-not.

ANACARDIACEÆ.

Rhus toxicodendron, *L.* Poison Ivy.

SAPINDACEÆ.

Acer spicatum, *Lam.* Mountain Maple. Very abundant everywhere; grows usually in clumps, generally a mere bush.

Acer saccharinum, *Wang.* Owing to the scarcity of other hard wood this is highly valued for hard fuel and charcoal. Considerable quantities of sugar are made from it, both by Indians and whites. This tree is not once met with on the immediate lake shore; it can be found only some distance inland. In addition to the above mentioned maples Acer Pennsylvanicum and Acer rubrum are occasionally found, it is said.

LEGUMINOSÆ.

Vicia Americana. *Muhl.* Vetch. *c.*
Lathyrus maritimus. *Bigelow.* Beach Pea.

Grows in patches in coarse sand or gravel, where no other plants thrive. Resembles very much the common field pea. Along the whole length of the shore within the limits of Minnesota, it was observed in only three places, viz: French River, Two Island River and Poplar River.

Lathyrus ochroleucus. *Hook. c.*

ROSACEÆ.

Prunus Pennsylvanicus. *L.* Wild Red Cherry.

Prunus Virginiana. *L.* Choke Cherry. *v. r.*

Spiræa opulifolia. *L.* Nine-Bark. Here, unlike further south, it shuns the soil, but clings to bare rocks, often within the sweep of the waves.

Spiræa salicifolia. *L.* Common Meadow Sweet.

Agrimonia Eupatoria. *L.* Common Agrimony.

Geum album. *Gmelin.* Makes a good substitute for tea; was sometimes used as such on the survey of the north shore.

Geum strictum. *Ait.* *c.*

Potentilla Norvegica. *L.* Five-Finger.

Potentilla fruticosa. *L.* Shrubby Five-Finger.

Common on bare, rocky shores north of Two Island River, becoming more abundant further north.

Potentilla tridentata, *Ait.* More common and less confined to rocks than the last.

Fragraia Virginiana, *Ehrhart.* *c.* Strawberry.

Fragraria vesca, *L.* *c.* Very prolific.

Rubus Nutkanus, *Mocino.* White Flowering Raspberry. Occurs everywhere on dry soil. Its showy white blossoms are about as large as those of the wild rose. The fruit is large and looks tempting but has a peculiar acid flavor which makes it inferior to that of the R. strigosus.

Rubus triflorus, *Richardson.* Dwarf Raspberry.

Rubus strigosus, *Michx.* Wild Red Raspherry. *c.* Especially abundant and prolific on burnt places a few years after fires. Both the quantiy and the quality of the fruit is extraordinary.

Rosa lucida, *Ehrhart.* Dwarf Wild Rose (?).

Amelanchier Canadensis, *Torr. & Gray.* Pigeon Point.

Pyrus Americana, *D. C.* American Mountain Ash. *c.*

The large cymes of white blossoms in summer as well as the crimson fruit in autumn and winter give a pleasant relief to the dark background of evergreen. The tree was in full bloom at Duluth on the 20th of June, while on Pigeon River some were found in flowers nearly two months later.

Cicuta maculata. *L.* Spotted Cowbane.

Cicuta bulbifera. *L.*

Sium Carsonii. *Durand*, ined. Temperance River.

ARALIACEÆ.

Aralia hispida. *Michx.* *c.* Bristly Sarsaparilla.

Aralia nudicaulis. *L* Wild Sarsaparilla. *c.*

CORNACEÆ.

Cornus Canadensis. *L.* Dwarf Cornel.

Cornus circinata. *L'Her.* Round-leaved C.

Cornus stolonifera. *Michx.* *c.* Gray attaches the name "Kinnikinnik" to C. sericea. This only serves to mislead beginners, and gives rise to dis- the name "Kinnikinnik" applies with equal propriety to C. stolonif

Arctostaphylus uva ursi. The Indians use the inner bark of the two former and the dried leaves of the latter as tobacco; hence the same name.

Cornus alternifolia. *L. r.* Poplar River.

CAPRIFOLIACEÆ.

Linnæa borealis. *Gronov.* So abundant that it often forms a beautiful setting in the moss carpets in the woods. It was in blossom at Duluth on the 20th of June, and on the 27th of September it was still found blooming at Grand Marais. (See Foster and Whitney.)

SAXIFRAGACEÆ.

Ribes Cynosbati. *L.* Comomn Wild Gooseberry.

Ribes lacustre, *Poir.* Agate Bay.

Ribes prostratum, *L'Her.* Fetid Currant. Known in this region by the name of "Skunk Berry." More prolific than the Ribes rubrum and the berries larger, but hardly eatable on account of the unpleasant odor.

Ribes floridum, *L.* Red Currant. Little Marais. Plant and fruit like the red garden currant. Without the fruit the plant is not easily distinguished from the R. prostratum.

Parnassia palustris, *L.* Grand Portage Island.

Saxifraga Pennsylvania, *L. c.*

ONAGRACEÆ.

Circæa apina, *L.* Enchanter's Nightshade, *c.* This plant contains many raphides.

Epilobium angustifolium, *L.* Great Willow Herb. Very common, especially on burnt land.

Epilobium coloratum, *Muhl. c.*

Epilobium palustre.

Œnothera biennis, *L.* Common Evening Primrose.

UNBELIFERÆ.

Hydrocotyle umbellata, *L.* Water Pennywert.

Sanicula Marilandica, *L.* Sanicle.

Heracleum lanatum, *Michx. v. c.*

Lonicera hirsuta, *Eaton.* Hairy Honey Suckle, *c.*

Lonicera ciliata, *Muhl.* Fly Honey Suckle.

Diervilla trifida, *Mœnch, v. c.* Bush Honey Suckle. Forms a large part of the underbrush.

Sambucus pubens. *Michx.* Red-berried Elder.

Viburnum Opulus. *L.* Bush Cranberry. *c.*

Much stunted and fewer berries in each cyme, which nearly leads one to take it for V. pauciflorum.

RUBIACEÆ.

Galium asprellum. *Michx.* Rough Bed-Straw.

Galium triflorum. *Michx.* Sweet-scented Bed-Straw.

Houstonia purpurea. *L.* *Var.* longifolia. Gooseberry River.

COMPOSITÆ.

Eupatorium purpureum. *L.* **Joe Pye Weed.** *c.*
Aster cordifolius. *L.* Little Marais.
Aster sagittifolius. *Willd.* Agate Bay.
Aster pumiceus. *L.* Grand Portage Island.
Aster gramminfolius. *Pursh.* *c.*
Aster ptarmicoides. *Torr and Gray.*
Solidago bicolor. *L.* Golden Rod. *c.*
Solidago Muhlenbergii. *Torr and Gray.*
Solidago Canadensis. *L.*
Heliopsis lævis. *Pers.* Ox-Eye. *c.*
Anthemis nobilis. *L.* Beaver Bay.
Senecio tomentosus, *Michx.* Put in Bay.
Achillæa Millefolium, *L.* Common Yarow. Abundant all along the shore, forming a fringe of white just on the line between the forest trees and the waves. Was not found in other situations. A few specimens with light purple flowers were seen.
Gnaphalium decurrens, *Ives.* Everlasting. Deronda Bay and Grand Portage Island.
Senecio aureus, *L.* Golden Ragwort.
Arnica mollis, *Hook.*
Cirsium lanceolatum, *Scop.* Common Thistle.
Hieracium Canadense, *Michx.* Hawk Weed. *c.*
Nabalus albus, *Hook.* White Lettuce.
Mulgedium floridianum, *D. C.* False Blue Lettuce.

LOBELIACEÆ.

Lobelia Kalmii, *L.* Abundant on bare trap shores north of Agate Bay.

CAMPANULACÆ.

Campanula rotundifolia, *L.* Harebell. *c.*
Campanula rotundifolia, *L. Var.* linifolia. Pigeon Point.
Campanula aparinoidei, *Pursh. c.* Marsh Bell Flower.

ERICACEÆ.

Gaylussacia resinosa, *Torr. & Grry. c.* Black Huckleberry.
Vaccinium Oxycoccus, *L.* Small Cranberry.
Vaccinium uliginosum, *L.* Bog Billberry.
Chiogenes hispidula, *Torr. & Gray.* Pigeon Point.
Arctostaphylus uva ursi, Spring Bearberry.
Ground thickly covered by it in open places; Indians use the dried leaves to mix with their tobacco for smoking and call it "Kinnikinnik."
Gaultheria procumbens, *L.* Wintergreen. Palisades.
Epigæa repens, *L.* Trailing Arbutus. Minnesota Point.

c **Pyrola** elliptica, Shin-leaf.
Pyrola chlorantha, *Swartz*. French River.
Pyrola secunda, *L.* *Var.* pumila.
c Moneses uniflora, (*L.* Pyrola uniflora.)
Monotropa uniflora, *L.* Indian Pipe. Grand Marais.

PLANTAGINACEÆ.

Plantago major, *L.* Common Plantain.

PRIMULACIÆ.

Primula Mistassinica, *Michx.* Trap shores.
c Trientalis Americana, *Pursh.* Star Flower.
Lysimachia stricta, *Ait.* Split Rock River.
Lysimachia ciliata, *L.* Split Rock River.

LENTIBULACEÆ.

Utricularia, minor *L.* Smaller Bladderwort. Duluth.

SCROPHULARIACEÆ.

c Chelone glabra, *L.* Turtle-head.
Mimulus ringens, *L.* Monkey Flower.
Gratiola pilosa, *Michx.* Agate Bay.
Veronica arvensis, L. Corn Speedwell. Duluth.
Melampyrum Americanum, *Michx.* Cow-wheat. *c.*

LABIATÆ.

Mentha arvensis, *L.* Corn Mint. Baptism River.
Lycopus Virginicus, *L.* Bugle-weed. Knife River.
Lycopus Europæus, *L.* *Var.* integrifolius and *var.* sinuatus. Baptism Riv
Brunella vulgaris, *L.* Common Self-heal. Duluth.
Galeopsis Tetrahit, *L.* Common Hemp-nettle. *c.* At some places the co of the flower is a yellowish white, while at others it is purple.
Phlomis tuberosa, *L.* Jerusalem Sage. Knife River.

BORRAGINACEÆ.

Mertensia paniculata, *L.* Lungwort. Abundant and showy.
Echinospermum Lappula. *Lehm.* Stickseed. Duluth.

GENTIANACEÆ.

Halenia deflexa, *Griesbach,* Supurred Gentian.
Menyanthes trifoliata, *L.* Buckbean. *c.*

POLYGONACEÆ.

Polygonum cilinode, *Michx.* *c.*
Rumex Acetosella, *L.* Sorrel. *c.*

ELÆAGNACEÆ.

Shepherdia Canadensis, *Muhl.* Dry shores.

SANTALACEÆ.

Comandra livida, *Richardson.* Bastard Toad Flax.

URTICACEÆ.

Urtica gracilis, *Ait.* Nettle. Agate Bay.

CUPULIFERÆ.

Corylus Americana. *Walt.* Knife River.

Corylus rostrata. *Ait.* Everywhere and (contrary to Foster and Whitney) fertile. In some places the bushes reach a height of fifteen feet, with stems from one to one and a half inches in diameter. The tops bend over from the weight of the fruit.

Ostrya Virginica. *Willd.* Hop-Hornbeam. Reported as growing on the ridges in the interior.

BETULACEÆ.

Betula lutea. *Michx.* Yellow Birch. Inland.

Betula papyracea. *Ait.* Paper or Canoe Birch.

This tree is valuable not so much for its wood as for the great variety of uses to which the bark can be turned. In many instances the tree reaches a height of seventy feet.

Betula glandulosa. *Michx.* Dwarf Birch. Swamps.

Betula rotundifolia. *Spach.* Swamps.

Alnus viridis. *D. C.* Green Alder. Bare rocks and dry banks.

Alnus incana. *Willd.* Swamps and wet banks.

SALICEÆ.

Populus tremuloides. *Michx.* American Aspen. *v. c.*

Populus grandidenta. *Michx.* Unusually large.

Populus balsamifera. *Var.* candidans. *L.* Balm of Gilead. *c.*

CONIFERÆ.

Pinus Banksiana, *Lambert.* Scrub Pine. *c.*

Pinus resinosa, *Ait.* Red Pine. *c.*

Pinus Strobus, *L.* White Pine. This is rather scarce along the shore, but is abundant a few miles inland. It sometimes forms a forest, but is more frequently seen single or in clumps of a dozen or two interspersed among the other trees. The decaying trunks lying in the shade of a young growth show that the tree is by no means stunted in this latitude. At Knife River a fallen tree was measured and found to be 125 ft. in length and 3½ to 4 ft. in diameter.

Abies nigra, *Poir.* Black Spruce.

Albies alba, *Michx.* White Spruce. *c.*

Albies balsamea, *Marshall.* Balsam Fir. *c.* The Canada Balsam is obtained from the blisters in the bark of this tree.

Larix Americana, *Michx.* Tamarack. *c.* It is here found both in swamps and on dry land.

Thuja occidentalis, *L.* Arbor Vitæ. *c.* Though the trunk is frequently two feet in diameter, it tapers so rapidly that it is of little value as timber. The trees either standing or fallen make an almost impassable barrier to the explorer.

Juniperus communis. *L.* *Var.* alpina. *c.*

Toxus baccata. *L.* *Var.* Canadensis. American Yew.

ARACEÆ.

Calla palustris. *L.* Bogs, Duluth.

Acorus Calamus. *L.* Sweet Flag. Knife River, Duiuth.

TYPHACEÆ.

Sparganium simplex. Hudson Bay Reed. Agate Bay.

NAIADACEÆ.

Potamogeton crispus. *L.* Pond Weed. Agate Bay.

ORCHIDACEÆ.

Habenaria obtusa. *Richardson.* *c.*

Habenaria orbiculata. *Torr.* *c.*

Habenaria psycodes, *Gray.* *c.*

Goodyera pubescens. *R. Br.* *c.*

Spiranthes Romanzoviana. *Chamisso.*

IRIDACEÆ.

Iris versicolor. *L.* Blue Flag.

Sisyrinchium Bermudiana. *L.* Blue Eyed Grass.

LILIACEÆ.

Streptopus amplexifolius. *D. C.* Twisted Stalk.

Clintonia borealis. *Raf.* *v. c.*

Smilacina trifolia. *Ker.* Putin Bay.

Lilium Philadelphicum. *L.* Trap shores.

JUNCACEÆ.

Juncus alpinus, *var.* insignis. *Fries.*

Juncus Canadensis. *J. Gray.* *Var.* co-arctatus.

CYPERACEÆ.

Eriphorum alpinum. *L.* Cotton Grass.
Carex polytrichoides. *Muhl.* Little Marais.
" stipata. *Muhl.* Moose Lake.
" trisperma. *Dew.* Putin Bay.
" canescens; *var.* vitilis. *L.* Agate Bay.
" Deweyana. *Schw.* Agate Bay.
" lagopodioides. *Schk.* Agate Bay.
" stricta. *Lam.* Agate Bay.
" lenticularis. *Michx.* Agate Bay.
" crinita. *Lam.* Putin Bay.
" gynandra. *Schw.* Agate Bay.
" irrigua. *Smith.* Putin Bay.
" alpina. *Schwartz.* Temperance River.
" livida. *Willd.* Greenwood River.
" arctata. *Boott.* Agate Bay.
" flexilis. *Rudge* Knife River.
" filiformis. *L.* Putin Bay.
" lanuginosa. *Michx.* Common everywhere.
" riparia. *Curtis.* *c.*
" paludosa. *Good.* *c.*
" retrorsa. *Schw.* Moose Lake. *c.*
" intumescens. *Rudge.* *c.*
" monile. *Tuckerman.* Agate Bay.
" oligosperma. *Michx.* Baptism River.

GRAMINEÆ.

Zizania aquatica. *L.* Indian Rice. Water Rice.
Calamagrostis Canadensis. *Beauv.* Blue Joint.
Poa caesia. *Smith.* Meadow grass.

FILICES. (Ferns.)

Polypodium vulgare. *L.* (?)
Pteris aquilina. *L.* Common Brake.
Adiantum pedatum. *L.* Maidenhair.
Onoclea sensibilis. *L.* Sensitive Fern. *c.*
A number of other species of ferns were collected but not identified.

LYCOPODIACEÆ. (Club Moss.)

Lycopodium inundatum. *L.* *r.* Pallisades.
Lycopodium annotinum. *L.* *c.*
Lycopodium dendroideum. *Michx.* Ground Pine.
Lycopodium clavatum. *L.* *c.*
Lycopodium complanatum. *L.* *c.*

The following is a list of plants that either constitute the greater part of vegetation on the comparatively bare belt of a few rods width in immediate contact with the water, or grow there exclusively. The margin of the forest is:

eral a well defined line, reaching, where the conformation of the coast admits, as far down as the highest waves are thrown. The strip between this line and the level of the lake is exposed to winds and waves, and destitute of soil, except what filters into cracks of the rocks, or is retained in some ancient pot-hole.

Campanula rotundifolia. *L.* Harebell. *Var.* linifolia. Both common, and exclusively on this belt.

Potentilla tridentata. *Ait.* Becomes less common northward. Is most abundant at Duluth. Grows occasionally inland.

Potentilla fructicosa. Makes its first appearance at Knife River; grows more common thence northward. Only on rocks, and more rare inland.

Aster gramminifolius. Knife River, and northward. Its roots are firmly set into the cracks.

Solidago bicolor. Takes the higher and more favorable positions.

Primula Mistassinica. Wet cavities or pot-holes, usually with Juncus and Drosera. Common on flat trap.

Drosera longifolia. Same as preceding.

Juncus alpinus. Same as preceding.

Draba arabisans. On high rocks.

Barbara vulgaris. Sheltered and stony beach near water level at Putin Bay.

Arabis Drummondii. High walls at Castle Danger.

Achillea Millefolium. Forms a white fringe along the timber line. The most retired, but always in its place.

Rhamnus alnifolius. *L'Her.* Buckthorn.

Spiræa opulifolia. Very common. About the only shrub on many rocky shores; clings to the lowest and most exposed ones, also on high walls.

Thuja occidentalis. Not so common as inland, but maintains its hold upon life in the most unfavorable positions. Often the only representative of the vegetable kingdom on a lone rock in the lake, where its stem and branches plainly indicate the direction of the prevailing winds and waves.

Alnus viridis. Less thrifty than inland.

Lilium Philadelphicum. Occasionally on trap.

Lathyrus maritimus. Gravelly or sandy beaches.

In addition to the above, there are three species of Gramineæ which have not been identified. These are often found on the most exposed places.

Additional Species identified at the University, by B. Juni.

Phacelia bipinnatifida. *Michx.* Near campus.

Draba Caroliniana. *Walt.* Abundant on campus.

Alyssum calycinum. *L.* Around Agricultural College.

Erodium cicutarium. *L'Her.* Agricultural College.

Camelina sativa. *Crantz.* Agricultural College. Only two specimens found. May not appear again.

Aster multiflorus. *Ait.* Campus.

Lychnis vespertina. *Sibth..* Near campus. Not viscid.

Oxybaphus nyctagineous. Sweet. Campus.

Acerates lanuginosa. *Decaisne.* Near campus.

Veronica perigrina. *L.* Near campus.

Lycium vulgare. *Dunal.* Sidewalks, E. D.; rare.

Linaria vulgaris. *Mill.* Common on University Avenue.

Arabis hirsuta. *Scop.* Common on the bluffs.
Prunus pumila. *L.* Rare; bluffs.
Cardamine hirsuta. *L.* Brook.
Eleocharis palustris. *R. Br.* Brook.
Scirpus validus. *Vahl.* Brook.
Lathyrus palustris. *L.* Near the brook.
Troximon cuspidatum. *Pursh.* Ft. Snelling to Chaska.
Veronica Virginica. *L.* White Bear.
Veronica Americana. *Schweinitz.* Brook.
Veronica scutellata. *L.* Brook.
Asclepias ovalifolia. *Deçaisne.* White Bear.
Baptisia tinctoria. *R. Br.* White Bear
Scrophularia nodosa. *L.* Campus.
Verbena hastata. *Michx.* Campus.
" urticifolia. *L.* Campus.
" stricta. *Vent.* Campus.
" bracteosa. *Michx.* Campus.
Spiræa opulifolia. *L.* Bluffs.
Solidago odora. *Ait.* Brook.
Stipa spartea. *Trin.* Campus.
Amphicarpum. *Purshii, Krunth.* Campus.

CAREX.

Backii. *Boott.*
teretiuscula *Good.*
disticha. *Huds.*
vulpinoidea. *Michx.*
conjunta. *Boott.*
rosea. *Schk.*
tenella. *Schk.*
scoparia. *Schk.*
tenuiflora. *Wahl.*
stellulata. *L.*
vulgaris. *Fries.*
aquatilis. *Wahl.*
aurea. *Nutt.*
granularis. *Muhl.*
Torreyi. *Tuckerman.*
flaccosperma. *Dew.*
gracillima. *Schw.*
digitalis. *Willd.*
Pennsylvanica. *Lam.*
Richardsonii. *R. Br.*
pubescens. *Muhl.*
miliacea. *Muhl.*
lanuginosa. *Michx.*
hystricina. *Willd.*
longirostris. *Torr.*

The sedges enumerated above have been found in the vicinity of the University. Taking into account those found on the north shore, there have been in all forty-six sedges identified the past summer, fully three-fourths of which have not heretofore been identified; at least they were not published. This number by no means represents all the species of Carex in this State. The sedges are commonly not distinguished from the grasses proper. They form a large part of the food for cattle and wild ruminants, especially in woody districts.

VIII.

REPORT ON THE GENERAL MUSEUM.

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY FOR 1878.

By N. H. Winchell, Curator.

The work in the museum has been carried on mainly in the laboratory of the Geological Survey. In the earlier part of the summer Mr. Herrick prepared a number of thin sections of rock for the microscope, collected by the survey in different parts of the State. The excellent lathe of Mr. A. A. Julien, purchased for this purpose, with the accompanying apparatus, has proved eminently useful, and will become still more so as the laboratory work of the survey progresses. Later in the summer plants and birds were added to the museum by Mr. Herrick and Mr. Juni, and the botanical collection now assumes considerable proportions. At the same time many memoranda of unexpected localities, and variations or peculiarity in species, have been preserved for use when systematic work on these collections shall be attempted. A few plants from Iowa have been obtained of Mr. Roberts.

Further collections have been made of fossils from the Trenton limestone, and also from the so-called "Northwestern limestone" of the drift in the vicinity of Minneapolis. Mr. Herrick's ornithological notes are reported to Dr. Hatch.

On the return of parties from the field-work of the survey, a systematic examination and registration of the material gathered during the past six years, not previously examined and reported, was begun in the laboratory, and has been in progress up to the present time. These comprised about two hundred boxes and miscellaneous packages of specimens, some of which will require

minute examination and study. This is true particularly of the crystalline rocks of the northern part of the State. For the purpose of this work, and owing to the large increase of the number of boxes the present year, another room in the basement of the University was occupied by order of the Executive Committee, and was fitted with suitable shelving and tables for storage and convenient handling. The accompanying catalogue shows how far the registration has proceeded, and the general character of the specimens so far as examined.

At the same time the work of mounting the *Megatherium*, mentioned in the last report, which had been temporarily re-stored in an empty case of the north room, was begun, and as much time given to it as the various other duties of the Curator would permit. It will require some weeks further time, but it will not be long now before it will be completely set up, and will constitute one of the chief attractions of the Museum.

Mr. W. H. Chambers, a student in the University, has presented a fine specimen of Rock Sturgeon (Acipenser rubicundus. Le. S.) taken by him in the Mississippi, near the University. which has been mounted by Mr. Wm. Howling, of Minneapolis, and is on exhibition in the Zoological apartment of the Museum.

From time to time specimens of minerals are presented to the Museum. These will be found acknowledged in the following catalogue. A circular relating to duplicates in the Museum, and to exchanges for the same, was issued in December, for distribution to parties desiring exchange.

CATALOGUE OF SPECIMENS REGISTERED

In the General Museum in 1878.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
219	Oct, 1872.	Geol. Survey	Limestone	2	Winona, Minn	St. Law'ce	N. H. Winchell
247	May, 1873	A. M. Hutchinson.	Galena	1	Spring Valley, Minn	Galena	Presented by A. M. Hntchinson
854	1872.	A. D. Roe	Tetrahedrite (Gray copper)	1	Simsbury, Ct.		Presented by A. D. Roe
855	"	"	Scapolite	1	Gouverneur, N. Y		" "
856	"	"	Amphibole (bladed tremolite) in Dolomite	1	Canaan, Ct.		" "
857	"	"	Talc and Dolomite (Bittu Spar)	1	Middlefield, Mass		" "
858	"	"	Mica and Chlorite	1	"		" "
859	"	"	Molybdenite	1	Westmoreland, N. H		" "
860	"	"	Iron (Octahedral)	1	Franklin, N. J		" "
861	"	"	Amphibole (Tremolite)	5	Canaan, Ct		" "
862	"	"	Amphibole (Black Tremolite)	1	"		" "
863	"	"	Siderite (Spathic Iron)	1	Roxbury, Vt		" "
864	"	"	Fluorite (Fluate of Lime) Var. Chlorophane	1	Trumbull, Ct		" "
865	"	"	Pectolite (on Trap)	1	Bergen, N. J		" "
866	"	"	Calcite	1	"		" "
867	"	"	Limonite (Stalactitic)	1	Salisbury, Ct.		" "
868	"	"	Magnetite (in massive Garnet)	1	Chester, Vt		" "
869	"	"	"Lithomarge"	3	Chester, Mass		" "
870	"	"	Chromite and Serpentine	1	"		" "
871	"	"	Vein of Prehnite (in Gneiss)	2	Bellows Falls, Vt		" "
872	"	"	Amphibole (Fibrous Tremolite)	1	Canaan, Ct.		" "
873	"	"	Calcite (Iceland Spar)	1	Gouverneur, N. Y		" "
874	"	"	Amphibole (Radiating fibrous Tremolite)	1	Canaan, Ct.		" "
875	"	"	Limonite	2	Salisbury, Ct.		" "
876	"	"	Amphibole (Asbustos)	1	Chester, Mass		" "

Catalogue of Specimens Registered in the General ***Museum*** *in 1878.*—Continued.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2178	1873.	Geol. Sur	Impure Kaolin	6	Brich Coolie		N. H. Winchell [pottery.)
2179	"	"	Clay	1	Cottonwood River	Cret	" (wo'ld not m'ke
2180	"	"	Lignite	Indf	Crow Creek, near Redwood Falls		"
2181	"	"	Ferruginons Shale (Silurian surface) from Sub-Cretaceous	2	Mankato		"
2182	"	"	Concretionary (Impure) Kaolin	4	Post's Creek,(Minn.riv.)		"
2183	"	"	Contretionary (Impure) Kaolin	3	" "		"
2184	"	"	Shakopee Limestone	2	Kasota		"
2185	"	"	Ripper-marked Sandstone	1	New Ulm		"
2186	"	"	Inoceramus, &c	Indf	Near Sioux City, Iowa	Cret	"
2194	"	"	Peat	2	Lura	Drift	W. Z. Haight
2195	1874.	"	Greenisb Limestone	1	Twin Lakes, Freeb'n co	Drift	N. H. Winchell (from boulder).
2196	"	"	Limestone	4	Northw'd, Worth co., Ia	Dev	"
2197	"	"	Stromatopora	7	3 ms. S. of Northw'd, Ia	Dev	"
2198	A'g. 5,'74.	"	Rose Quartz	2	Near Custer's Park, Black Hills		"
2199	" 8,'74.	"	Quartzyte	5	Near Custer's Park. Black Hills		"
2200	J'y 23,'74.	"	Phonolyte	2	Horse Shoe Ridge, Heeng-ya-ka-gaP'k, (Inyan Kara) D. T.		"
2201	"	"	Pnonolitic Trap	3	Sum't Heeng-ga-ka-ga		"
2202	J'y 26,'74.	"	Sandrock	3	Castle Valley, B. Hills		"
2203	J'y 24,'74.	"	Limestone	2	Near Heeng-ya-ka-ga, Black Hills		"
2204	J'y 25,'74.	"	Limestone	1	Minnelusa Valley, Black Hills		"

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2205	J'y 31, '74	Geol. Sur	Felsite	3			N. H. Winchell
2206	" 29, '74	"	Garnetiferous Mica Schist	6			"
2207	A'g 12, '74	"	Chlorite Slate	1			"
2208	J'y 23, '74	"	Limestone	3			"
2209	A'g 17, '74	"	Fossil Wood	3			"
2210	J'y 29, '74	"	Mica Schist with various minerals	5			"
2211	J'y 26, '74	"	Limestone	6			" The great limestone formation of the Black Hills.
2212	1874.	"	Peat	1		Drift	N. H. Winchell
2213	J'y 21, '74	"	Gypsum	7		Jurass	"
2214	J'y 31, '74	"	Granyte (with Tourmaline Crystals)				"
2215	J'y 30, '74	"	Granyte (with Tourmaline)				"
2216	J'y 25, '74	"	Sandstone, Pinkish	12			" Under "Carb. Limestone."
2217	J'y 21, '74	"	Red Sandstone				"
2218	A'g 9, '74	"	Limestone				"

Catalogue of Specimens Registered in the General Museum in 1878—Contined.

Catalogue of Specimens Re istered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2239	1874.	Geol. Sur	Stromatopora	1	LeRoy	Dev.	N. H. Winchell
2240	"	"	Favosites	2	3 ms. S. of Northwood, Iowa	"	"
2242	"	"	Mica Schist	1	Black Hills, Dak.		"
2243	A'g 10, '74	"	Iron Ore	1	Eastern part of Blk. Hills		"
2244	A'g 1, '74	"	Mica Schist (with Crystals)	2	2 ms. S. W. of Harney's Peak		"
2245	1874.	"	Sand	1	Minneapolis	St. Peter	" (W. drift St. Anthony Falls tunnel.
2246	"	"	Sand	1	"	"	N. H. Winchell, (E. drift St. Anthony Falls tunnel.
2247	"	"	Shale	Indf	"	Trenton	N. H. Winchell, (St. Anthony Falls tunnel.
2248	"	Mr. Cole	Lignite	Indf	Near Albert Lea	Drift	Presented hy Mr. Cole
2249	"	Geol. Sur	Quartz Sand (blackened by Iron)	Indf	Near Austin		N. H. Winchell, (Gregson's mill)
2250	"	"	Sand Concretions	Indf	"	Cret.	" "
2251	1872.	S. D. Haskin	Fossil Wood	1	Near Kasota	Drift	Presented by S. D. Haskin
2252	"	Geol. Sur	Sand	Indf	Winona	St. Croix	N. H. Winchell
2253	?		Red Ochre	1			
2254	1872.		Argentiferous Galena	1	Bear Butte, Dak. Ter.		From the Eldofusia Mine
2255	"	Geol. Sur	Magnesia Sulphate (mostly)	1	Mantorville		N. H. Winchell, (Weathers from face of the bluff at Willson's Quarry.)
2256	"	"	Fine Red Clay	Indf	Stillwater ?	Drift	N. H. Winchell, so-called Tripoli.
2257	"	"	"Lacustrine Clay"	4	Rochester	"	N. H. Winchell

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2258	1872.	A. M. Hutchinson.	Colored Clays	2	Near Spring Valley	Cret	Presented by A. M. Hutchinson
2259	"	Geol. Sur	Fossiliferous Slabs	Indf	Taylor's Falls	Potsdam	N. H. Winchell
2260	1873.	"	Iowa Coal	1	Iowa	Carbonif.	"
2261	"	W. W. Folwell	Tully Limestone	1	Waterloo, N. Y	Dev	Presented by W. W. Folwell
2262	"	"	Clay Slate	1	Genesse Co., N. Y	Mos. shale	" "
2263	"	Geol. Sur	Fossiliferous Limestone	6	Glencoe	Drift	N. H. Winchell (boulder)
2264	"	N. Butler	Granyte	1	Prairie riv. Falls (upper)		Presented by N. Butler
2265	"	"	Quartzyte	2	Prairie riv. Falls		" "
2266	"	"	Ferruginous Sandstone	1	Pokegama Falls	Potsdam	N. Butler, (half way down the pitch of the falls.
2267	"	"	Quartzyte	1	T. 58, R. 23.		Presented by N. Butler
2268	"	"	Quartzyte	1	Sec. 1, T. 56, R. 23		" "
2269	"	"	Red Granyte	1	Sec. 3, T. 56, R. 23		" "
2270	"	"	Red Granyte	1	Sec. 34, T. 57, R. 23		" "
2271	"	"	Red Sand (same as 2266)	Indf	Pokegama Falls	Potsdam	N. Butler, (east side of Falls.)
2272	"	A. M. Hutchinson.	Wood and Peat	Indf	Near Pleasa't Gr've, Fillmore Co	Interglac'l	Part of a log of wood 2 feet thick, found by digging a well, 45 feet below surface.
2273	"	S. D. Haskin	Pyrite on Cretaceous shale	2	Fox Lake, Martin Co	Drift	Presented by S. D. Haskin
2274	"	"	Gold	3	" "	"	" "
2275	"	Geol. Sur	Granyte	1	Minneapolis	"	N. H. W. (from drift bank near Winslow House.
2276	"	S. D. Haskin	Fossil Wood	1	6 miles below Jackson	"	Presented by S. D. Haskin
2277	"	E. D. Alden	Shale (Cretaceous)	1	Near Marshall, Lyon Co	"	From a bed of Fossiliferous Clay struck by digging a well, 36 feet below surface.
2278	"	"	Lignite	1	" "		Found in isolated pieces in above Clay.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2303	1873.	Geol. Sur........	Drillings of the Belle Plaine salt well bel. 420 ft.			....	See p. 82, 2d Annual Report....
2304	1872.	"	Quartzyte (purple, red and pink)..................			Potsdam...	N. H. Winchell.................
2305	J'ly 29,'74	"	Micaceous Gray Quartzyte..			....	" ....
2306	J'ly 29,'74	"	Hornblendic Gneiss......................			....	" ....
2307	1874.	"	Limestone with Acervularia (?)		co	Drift	" ....
2308	"	"	Agatized Wood.			"	J. Becker.......................
2309	J'ly 17,'74	"	Anchura biangulata. M. and H..................			Cret.......	N. H. W., from No. 2284, (No. 10)
2310	"	"	Scaphites larvæformis. M. and H...............			Cret.......	" " ....
[redacted]1	"	"	Scaphites Conradi. Mort. (?) fragment............			Cret.	" " ....
2312	"	"	Limopsis striato-punctata. Ev. and Shu........			Cret........	" " ....
2313	"	"	Nucula planimarginata. M. and H.			Cret.......	" " ....
2314	"	"	Amauropsis paludinæformis. M. [redacted] H.........			Cret.......	" " (No. 6).
2315	"	"	Vanikoro (Neretopsis) ambigua. M. and H......			Cret.......	" " ....
2316	"	"	Pteria linguiformis. Ev. and Shu................			Cret.......	" " (No. 17)
2317	"	"	Terebratula Helena. Whitf.......................			Cret.......	" " (Type specimens, Nos. 14 and 26)..

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2334	J'ly 21,'74	Geol. Sur........	Camptonectes bellistriatus. Meek..............	1	Redwater Valley, Dak.	Jurassic...	N. H. W., from No. 2358 (No. 20)
2235	J'ly 26,'74	"	Spirifera centronata. Winchell..........	1	Castle Val., near Divide	....	" [No. 29]..............
2336	"	"	Syringopora (sp?)..............................	1	" "	....	" [No. 30]...............
2337	"	"	Crinoidal column..............................	1	" "	....	" [No. 28]...............
2338	"	"	Productus (sp?)................. { On the same	1	" "	....	" [No. 31]...............
2339	"	"	Spirifera centronata. Winchell, { piece of rock.	1	" "	....	" [No. 32]...............
2340	"	"	Campophyllum or Amplexus (sp?)...............	1	" "	....	" [No. 33]...............
2341	"	"	{ Margin of a cup of a finely radiated coral, resembling Zaphrentis...................... }	1	" "	....	" [No. 34].. ....
2342	Aug. 4,'74	"	Inoceramus problematicus. Schloth.............	9	Spr'g Cr'k,S.E. Bl'k H'ls	Cret.......	" ....
2343	"	"	{ Zaphrentis (sp?) resembles somewhat centralis. Ed. and Haine,..................... }	2	" "	....	" [Nos. 36 and 37].......
2344	"	" { On same	{ Athyris (sp?) resembles form usuall referred to A. Polsyi............................. }	1	" "	....	" [No. 38]...............
2345	"	" { p'ce rock	Spirifera (sp?).................................	1	" "	....	" [No. 39]...............
2346	J'ly 27,'74	"	{ Lingulepis pinnæformis. M. and H. (See No. 2289.) Obolella nana and Obolus pectenoides. Whit.......... .... }	Indf	Castle Val., Black Hills	Potsdam..	{ " Type specimens of Obolus [Nos. 60, 61, 62, 63, 64 and 65]..............[& 35.
2347	A'g.1 ,'74	"	Matrix of Syringopora (probably mult-atteunata)	2	E. side Bl'k Hills, Dak.	....	N. H. W., from No. 2357 [Nos. 34
2348	Aug. 3,'74	"	Imprint of inside of ventral valve of Spirifera ?	1	French Creek, Dak.....	....	" [No. 36]........[12, 13.
2349	J'ly 17,'74	"	Terebratula Helena. Whitf......................	4	30 ms.N.B'le F'rche,Dak	Cret.......	" f'm No. 2284, [Nos. 7,
5350	J'ly 25,'74	"	Spirifera centronata. Win.....	7	Floral Val., Bl'k Hills..	....	" [Nos. 46, 47,49,50,51,52.]
2351	A'g. 10,'74	"	Spirifera centronata. Win....................	1	E. side Bl'k Hills, Dak..	....	" from No. 2357.........
2352	"	"	Retzia (eumetria of Hall. ?..... { On the same	1	" "	....	" " [No. 55.]
2353	"	"	Rhynchonella.................... { piece of rock.	1	" "	....	" " ....
2354	J'ly 11,'74	"	{ Siliceous Limestone (with impressions of woody fiber.............................. }	6	Ludlow's Cave..........	Cret.......	" [No. 40].............

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2355	J'ly 25,'74	Geol. Sur	Fossiliferous Limestone Cont. Spirifera controna Win. Syringopora and Streptorhynchus	Indf	Floral Valley, Blk. Hills		N. H. Winchell
2356	J'ly 26,'74	"	Syringopora	1	Divide bet. Floral and Castle Valleys		"
2357	A'g 10. '74	"	Fossiliferous Limestone	Indf	E. side of Black Hills		"
2358	J'ly 21,'74	"	Fossiliferous Conglomerate	"	Redwater Valley, Dak	Jurassic	"
2359	A'g 17, '74	"	Fossiliferous Concretions	"	Slave Butte, Dak	Cretaceous	"
2360	1875.	Wm. Bull	Argentiferous Galena	4	Clancey, Montana		Presented by Wm. Bull
2361	A'g 20, '75	G. A. Carlson	Terra Cotta Clay	1	Red Wing		Presented by C. A. Carlson
2362	M'y 22,'75	Chas. McCabe	Lignite	1	Calvert, Robinson Co., Texas		Presented by Chas. McCabe
2363	1875,	C. B. & F. A. Gordon	Kaolinized Granyte	Indf	Gordon, Renville Co., Minn		Presented by C. B. & F. A. Gordon.
2364	Nov. 1875	Geol. Sur	Octahedral Crystals of Limonite, after Pyrite	"	Lanesboro, Fillmore Co.		N. H. Winchell
2365	"	"	Crystals of Marcasite. (Pyrite)	"	" "		"
2366	1875.	H. C. Parlin	Drillings of well below 100 feet	"	Austin		Presented by H. C. Parlin
2367	"	Geol. Sur	Peat	"	St. Cloud	Drift	N. H. Winchell
2368	"	A. M. Hutchinson	Wood (from a well 28 feet below the surface)	"	Town of Beaver, S. of Spring Valley	"	Presented by A. M. Hutchinson
	"	Geol. Sur	Ankerite	3	Clear Grit, Fillmore Co.	St. Law.	N. H. Winchell
	"	"	Drillings from Artesian Well	Indf	E. Minneapolis		"
	"	"	Well Drillings	"	Mankato		
	Nov. 1875	"	Limonite. Pseudomorph, after Pyrite	1	Clear Grit, Fillmore Co.	St. Law.	N. H. Winchell (surface.)
	1875.	"	Interglacial Peat	3	Mower Co	Drift	" (50 feet below
	"	"	Clay (overlying No. 2374)	1	"	"	"
	"	"	Blue Clay (overlying No. 2375)	1	"	"	"

Catalogue of Specimens Registered in the Generat Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2377	1875.	Geol. Sur	Cretaceous Debris	...	Lime Springs, Iowa	Drift	
2378	"	Z. Haight	Sandstone ["bedrock"]	3	Martin Co		ight, from
2379	"	Geol. Sur	Trenton Limestone	1	Fountain, Fillmore Co	Trenton	from Tay-
2380	Aug 1875	"	Medina Sandstone	3	Medina, N. Y.	Medina	
2381	1875.	"	Cretaceous Sandstone	1	Austin	Cret	
2382	Aug 1875	"	Waverly Sandstone [Cut slabs 1x2½ ft.]	2	Ohio		
2383	1875.	"	Shakopee Limestone	1	Olmsted Co.	Shak.	
2384	"	"	Potsdam Limestone	1	Hinckley	Potsdam	
2385	"	"	Red Quartzyte	5	Pipestone Co		the Pipe-
2386	"	"	Calcite	6	Chatfield		
2387	"	"	Limestone	2	Clinton Falls, Steele Co	Trenton	from Ab- c. 23.
2388	"	"	Limestone	3	Montorville, Dodge Co.	Galena	from a ra-
2389	"	"	Limestone	1	S. side Mantorville, Dodge Co	"	rom Man-
2390	"	"	Limestone	2	Mantorville, Dodge Co.	"	from bank near 23
2391	"	"	Shakopee Limestone	1	Northfield	Shak	
2392	"	"	Limestone	2	Wabasha Co., nr. sec. 4, Oronoco, Olm. Co		from bot-
2393	"	"	Limestone	1	Sec. 8, Oronoco, Olm. Co	Shak	
2394	"	"	Calcite Geodes	1	Sec. 31, High Forest Olm. Co		William's

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2395	1875.	Geol. Sur.	Limestone	4	High Forest, Olm. Co.		M. W. Harrington
2396	"	"	Limestone	2	Root River, Olm. Co.	Galena	" A few rods W. of P. Brewers
2397	"	"	Aluminous Sandrock	1	Root River, Olm. Co.	Cret (?)	M. W. Harrington, a few rods E. of P. Brewer's
2398	"	"	Limestone	2	Rochester, Olm. Co	Galena	M. W. Harrington, one mile E. of P. Brewer's
2399	"	"	Limestone.	3	Rochester, Olm. Co.	"	M. W. Harrington, Gar'ck's Q'y
2400	"	"	Stalactitic Forms	Indf	Rochester, Olm. Co.	"	" "
2401	"	"	Limestone	3	Dodge Co.	Trenton	" Conc'd Q'r'y.
2402	"	"	Siliceous Hæmatite	1	3 or 4 ms. west Can. Falls		N. H. Winchell, [In outcrop]
2403	"	"	Sand Concretions	16	Lanesboro, Fill. Co	Jordan.	" [See 4th An. Rep.]
2404	"	"	Limestone	3	Cascade, Olm. Co	Trenton.	M. W. Harrington, Jackson's Quarry
2405	"	"	Weathered Shale	3	Cascade, Olm. Co.	"	M. W. Harrington, Jackson's Quarry.
2406	"	W. W. Folwell	Water Limestone	1	Margaretta, Erie Co., O.	Waterline.	Presented by W. W. Folwell
2407	"	Geol. Sur	Limestone (Rusty)	4	Sec. 31, High Forest, Olm. Co.		M. W. Harrington, Williams' Quarry
2408	"	"	Siliceous Concretion	1	Jordan, Fill. Co	Drift	N. H. Winchell
2409	"	"	Magnesian Limerock (Arenaceous)	1	Bear Creek, Rochester, Olm. Co	Shak	"
2410	"	"	Limestone	1	Sec. 7, Viola, Olm. Co.	Trenton.	"
2411	1876.	Centennial Ex.	Limestone (Drilled by Diamond Drill)	1			Drilled in Machinery Hall, and presented by Diamond Rock Boring Company
2412	1872.	Geol. Sur.	Hone-Stone	1	Austin	Cretaceous	N. H. Winchell, manufactured at Austin

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2413	1876.	Centennial Exb...	Amethyst, [cut]...	1	Lake Superior...	...	A. E. Foote...
2414	"	" ...	Micaceous Magnetite...	1	Crown Point, N. Y...	...	N. H. Winchell...
2415	"	" ...	Kaolinite...	Indf	Huron, Lawr'e Co., Ind.	...	" ...
2416	Dec. 1876	S. F. Peckham....	Talc. [Nacrite]...	1	Lime Rock, R. I...	...	Presented by S. F. Peckham...
2417	"	"	Granyte...	10	Smithfield and Cumberland, R. I...	...	" " ...
2418	"	"	"Granyte"...	1	Westerly, R. I...	...	" " ...
2419	"	Chas. McCabe....	Novaculite...	2	Hot Springs, Ark...	...	" Chas. McCabe...
2420	1877.	H. P. Van Cleve..	Beach-sand...	Indf	Sandwich Islands...	...	" H. P. Van Cleve.
2421	1875.	Geol. Sur...	Impure Hæmatite [and Jasper]...	1	2 miles N. E. Spring Valley...	Drift.. ...	John Kleckler...
2422	"	" ...	Amy daloid...	1	N. shore of L. Superior.	...	N. H. Winchell...
2423	"	" ...	Limestone...	1	Sec. 13, Wasioja, Dodge Co...	...	M. W. Harrington...
2424	"	" ...	Limestone...	1	Sec. 6, Marion, Olm. Co...	Trenton...	M. W. Harrington, Ireland & Crosier's Quarry...
2425	"	" ...	Limestone...	1	Wasioja, Dodge Co...	Galena...	M. W. Harrington, Blake's Mill...
2426	"	" ...	Calcareous tufa...	1	Fillmore Co...	Drift ...	N. H. Winchell...
2427	"	" ...	Travertine...	5	Section 10, Milton, Dodge Co...	" ...	M. W. Harrington, Irish's Kiln...
2428	"	" ...	Limestone...	4	Sec. 8, Oronoco, Olm. Co...	Shak.. ...	M. W. Harrington. Barrett's Quarry...
429	Dec. 1876	S. F. Peckham....	Gray Marble...	2	Rhode Island...	...	Presented by S. F. Peckham...
2430	"	"	White Marble with magnesean band...	1	" ...	...	" " ...
2431	"	"	Saccharoidal Marble...	2	" ...	...	" " ...
2432	"	"	Calcite with Amphibole...	1	" ...	...	" " ...

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2434	Oct. 1872.	Geol. Sur........	Lamellar Calcite..	3	St. Charles, Win. Co....	Drift......	N. H. Winchell, from "St. Peter slope."
2435	1876.	"	Surface Soil [Loam]..	Indf	Sec. 32, Yucatan, Houston Co..........	....	" ....
2436	"	"	Surface Soil [Loam]..	"	Sec. 35, Blackhammer, Houston Co..........	....	" ....
2437	"	"	Gravel..	"	Bloomfield, Fill. Co.....	....	From a Cretaceous Beach, Land of Peter Peterson, SW. ¼, Sec. 15...............
2438	"	"	Calcite..	2	Near Caledonia, Houston Co..............	....	N. H. W. From "Saint Peter Slope.".....................
2439	"	"	Limonite [Pseudomorph after Pyrite]..........	1	Caledonia, Houston Co.	Shak..... ..	N. H. Winchell..................
2440	"	"	Fossiliferous Limestone.......	3	Dayton, Hennepin Co...	Drift.......	N. H. Winchell. From boulders at Gula's Limekiln......
2441	"	"	Siliceous Fossiliferous Concretions............	Indf	Sec. 19, Union, Houston Co............	Shak	N. H. Winchell.... ....
2443	"	"	Shale, with Dikellocephalus...	Indf	Hokah, Houston Co.. .	St. Croix ..	" ....
2444	1875.	"	Bog Ore..	3	Etna, Fillmore Co......	....	" ....
2445	"	"	Iron Ore..	3	Vermilion L., Minn......	....	....
2446	"	"	Clay..	2	Near Spring Valley.....	?	N. H. Winchell. [On David Higby's land.].............
2447	"	"	Red jasper..	1	2¼ ms. NE. of Spring Valley....	Drift.......	Presented by J. Kleckler.......
[illegible]	J'ly 13, '75	"	Red jasper..................	1	Spring Valley..........	"	Presented by P. W. Thayer....
	1875.	"	Saccharoidal Sandstone	1	Sec. 8, Oronoco, Olm. Co	Low. Mag.	M. W. Harrington. Barretts'..
	"	"	Bituminous Shale.........................	Indf	Dubuque, Iowa.........	Maquok'ta	N. H. Winchell........
	"	"	Shell Marl............................	2	Galesburg, Mich	Drift.......	" ....
	1872.	J. F. Kenworthy..	Pecopteris villosa...........................	4	Mazon Creek, Grundy Co., Ill.,............	....	Records in Doubt.............

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of specimens.	Locality.	Formation	Collector and Remarks.
2455	1872.	Geol. Sur	Cretaceous clay	1	Austin	Cret.	N. H. Winchell
2456	1879.	"	Linomite [after Pyrite]	1	Wabasha	Low Sil	"
2457	1876.	Jas. D. Hutchinson	Cannel Coal	1	Pennsylvania	Carb.	Presented by Jas. D. Hutchinson
2458	"	"	Talc	1	Vermont		Presented by Jas. D. Hutchinson
2459	"	"	Tellurium	1	Colorado		Presented by Jas. D. Hutchinson. [Humboldt Mine]
2460	"	"	Chalcopyrite	1	Stratford, Orange Co., Vt		Presented by Jas. D. Hutchinson
2462	"	"	Sand Concretions	2	Sharon, Windsor Co. Vt		Presented by Jas. D, Hutchinson
2463	"	"	Graphite	1	Chelsea, Orange Co., Vt		Presented by Jas. D. Hutchinson
2464	"	"	Mica	1	Chelsea, Orange Co., Vt		Presented by Jas. D. Hutchinson
2465	"	"	Ophiolyte	1	Roxbury, Vt		Presented by Jas. D. Hutchinson
2466	"	Geol. Sur	Roofing Slate	7	Thomson		N. H. Winchell
2467	"	"	Dendrites on lithographic stone	1	Solenhofen, Bavaria		Presented
2468	"	Minnie Bolles	"Tennessee Marble	1	Tennessee		
2469	Oct. 1876	Geol. Sur	Unio	...	Minneapolis		N. H. Winchell. From the brick-clay
2470	"	"	Planorbis, &c	....	"		N. H. Winchell. From marl overlying brick-clay
2471	"	"	Cretaceous debris	Indf	Hennepin Co	Drift	N. H. Winchell
2472	1876.	A. N. Fuller	Fluorite	1	Silverton, Colorado		From San Juan Mines

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2473	1876.	A. N. Fuller	Argentiferous Galena	1	Silverton Col		From San Juan Mines
2474	"	"	Cubical Pyrites	1	"		" "
2475	"	"	Argentiferous Galena	4	"		" "
2476	"	"	Stephanite ["Brittle Silver"]	2	"		" "
2477	"	"	Quartz [Crystallized]	1	"		" "
2478	1877.	W. A. Brownell	Petrified Wood	4	Near So. Park, Col.		
2479	"	"	Endoceras proteiforme. Hall	2	S. Rutland, Jeff. Co. N. Y.	Utica	
2480	"	"	Graptolite	3	" "	"	
2481	"	"	Triarthus Beckil	2	" "	"	
2484	"	"	Fetid Limestone	1	Gr't. Bend, Jeff. Co., N. Y.	Trenton	
2490	1876.	Centen. Exhibit'n.	Red Hæmatite	2	Athens, Tenn		Presented by the Tennessee Centen. Com
2491	"	"	Red Hæmatite	1	Rockwood, Tenn.		Presented by the Tennessee Centen. Com.
2492	"	"	Red Hæmatite	1	Riceville, Tenn		Presented by the Tennessee Centen. Com
2493	"	"	Limonite	2	Stewart Co., Tenn		Presented by the Tennessee Centen. Com
2494	"	"	Limonite	2	Johnson Co., Tenn		Presented by the Tennessee Centen. Com
2495	"	"	Limonite	1	Anderson's Sta. N. Ga.		Presented by the Tennessee Centen. Com
[illegible]	"	"	Hausmannite [Manganese, Black oxide, impure]	1	Cooke Co., Tenn.		Presented by the Tennessee Centen. Com
[illegible]	1875.	Geol. Sur	Agate	1	High Forest, Olm. Co	Drift	N. H. Winchell
[illegible]	"	"	Limonite		SE. ¼, Sec. 8, Bloomfield, Fill. Co	Cret. ?	N. H. Winchell. From C. C. Temple's well

Catalogue of Specimens Registered in the General Museum in 1878—Contined.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2516	1876.	Geol. Sur........	Brick clay........	Indf	Shingle Creek, Minneapolis........	Drift	N. H. Winchell........
2517	"	"	Crag........	1	Crow River, Hennepin Co.......	"	" ....
2518	"	"	Calcite........	2	Caledonia, Houston Co.	St. Law....	" ....
2519	"	"	Debris from local drift........	5	Nr. Caledonia, Houston Co........	Drift	" ....
2521	"	"	Linomite. [Pseudomorph after Pyrite]........	3	Caledonia, Houston Co.	Shak......	" ....
2522	"	"	Linomite. [Pseudomorph after Pyrite]........	1	Crooked Creek Valley, Houston Co....	"	W. D. Belden........
2523	"	"	Fossiliferous chert........	14	Caledonia, Houston Co.	"	N. H. Winchell........
2524	"	"	Straparollus........	1	Caledonia, Houston Co.	"	Horace V. Winchell........
2525	"	"	Sand concretions........	2	Houston, Houston Co..	St. Croix..	N. H. Winchell........
2526	J'ly 13, '76	"	Fossiliferous chert........	9	Sec. 4, Canton, Fillmore Co........	Drift	N. H. W. [In loam near top of Lower Trenton terrace.]
2527	1876.	"	Fossiliferous limestone [slab]........	1	Spring Grove, Fillmore Co........	Trenton...	N. H. Winchell........
2529	J'ly 15, '76	"	Sandy loam........	....	Sec. 30, Money Cr'k, Houston Co........	Loam......	N. H. W. [Near Fox & Perkins mill........
[illegible]	1876.	"	Clay loam........	....	Sec. 30, Money Cr'k. Houston Co........	"	N. H. W. [Near Fox & Perkins mill........
[illegible]	"	"	Decaying mica schist........	Indf	Eden Prairie, Hennepin Co........	Drift	N. H. Winchell........
	"	Centennial Exb...	Linomite........	1	Shelby Furnace, Ala...	....	Selma, Rome & Dalton R. R....
	"	" ...	"	1	Tecumseh Furnace, Ala.	....	" " ....
	"	" ...	Limestone........	1	Tecumseh Furnace, Ala.	....	" " ....
	"	" ...	"	1	Woodst'k Furnace, Ala.	....	" " ....

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2536	1876.	Centennial Exb.	Iron ore	1	"Amberson's," Ala.		Selma, Rome & Dalton R. R.
2537	"	"	Peacock Copper ore	1	Stone Hill, Ga.		" "
2538	"	"	Charcoal	1	Stonewall, Ga.		" "
2539	"	"	Pine Charcoal [made in ovens]	2	Shelby Furnace, Ala.		" "
2540	"	"	Magnetite	Indf	Port Henry, N. Y.		From the New Bed Mine
2541	"	"	Barite	1	Mineral Point, Wis.	Galena	Wisconsin Geol. Sur.
2542	"	"	Linonite	2	Nr. Chattanooga, Tenn.		Tenn. Commissioners
2543	"	"	Linonite, [bog ore]	2	Vernon Co., Wis.	" Potsd'm"	Wisconsin Geol. Sur.
2544	"	"	Smithsonite	1	Mineral Point, Wis.	Galena	" "
2545	"	"	Fossiliferous Hæmatite	3	Mayville, Wis.	Clinton	" "
2546	"	"	Serpentine rock	1	Near Philadelphia, Pa.		The University of Penn. is built of this.
2547	"	Geol. Sur.	Dressed limestone	1	Rochester, Minn.	Trenton	Presented by W. D. Hurlbut
2548	"	"	Dressed Kasota stone	2	Kasota	Shakopee	Presented by Downs Bros.
2549	"	"	St. Lawrence limestone		St. Lawrence	St. Law.	N. H. W., filled with greensand
2550	"	"	Limestone boulders	1	" "	Drift	"
2551	"	"	Quicklime	Indf	" "	"	" burnt from No. 2550.
2555	"	"	Cretaceous debris	"	Minnetrista, Hennepin Co.	"	"
2556	"	Centennial Exb.	Washed Kaolin	"	Grand Rapids, Wis.	Laurent'n.	Wisconsin Geol. Sur.
2557	"	"	Unwashed Kaolin	"	" "	"	" "
2558	Aug. 1877	Geol. Sur.	St. Peter Sandstone	1	St. Paul, [Dayton's bluff]	St. Peter	N. H. W., eaten by lithodomous molluscs
2559	1877.	"	Limestone	1	St. Andrew's Rapids, Manitoba		N. H. W., 12 miles below Winnipeg
2560	June 1877	"	Selenite [crystals]	Indf	Fort Abercrombie, Dak		N. H. Winchell
2562	Aug. 1877	"	Fossiliferous slabs	"	St. Paul	Trenton	"

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2355	J'ly 25, '74	Geol. Sur	Fossiliferous Limestone Cont. Spirifera controna Win. Syringopora and Streptorhynchus	Indf	Floral Valley, Blk. Hills		N. H. Winchell
2356	J'ly 26, '74	"	Syringopora	1	Divide bet. Floral and Castle Valleys		"
2357	A'g 10, '74	"	Fossiliferous Limestone	Indf	E. side of Black Hills		"
2358	J'ly 21, '74	"	Fossiliferous Conglomerate	"	Redwater Valley, Dak	Jurassic	"
2359	A'g 17, '74	"	Fossiliferous Concretions	"	Slave Butte, Dak	Cretaceous	"
2360	1875.	Wm. Bull.	Argentiferous Galena	4	Clancey, Montana		Presented by Wm. Bull
2361	A'g 20, '75	G. A. Carlson	Terra Cotta Clay	1	Red Wing		Presented by C. A. Carlson
2362	M'y 22, '75	Chas. McCabe	Lignite	1	Calvert, Robinson Co., Texas		Presented by Chas. McCabe
2363	1875,	C. B. & F. A. Gordon	Kaolinized Granyte	Indf	Gordon, Renville Co., Minn		Presented by C. B. & F. A. Gordon.
2364	Nov. 1875	Geol. Sur	Octahedral Crystals of Limonite, after Pyrite	"	Lanesboro, Fillmore Co.		N. H. Winchell
2365	"	"	Crystals of Marcasite. (Pyrite)	"	" "		"
2366	1875.	H. C. Parlin	Drillings of well below 100 feet	"	Austin		Presented by H. C. Parlin
2367	"	Geol. Sur	Peat	"	St. Cloud	Drift	N. H. Winchell
2368	"	A. M. Hutchinson	Wood (from a well 28 feet below the surface)	"	Town of Beaver, S. of Spring Valley	"	Presented by A. M. Hutchinson
2369	"	Geol. Sur	Ankerite	3	Clear Grit, Fillmore Co.	St. Law.	N. H. Winchell
2370	"	"	Drillings from Artesian Well	Indf	E. Minneapolis		"
2371	"	"	Well Drillings	"	Mankato		
2372	Nov. 1875	"	Limonite. Pseudomorph, after Pyrite	1	Clear Grit, Fillmore Co.	St. Law.	N. H. Winchell (surface.)
2374	1875.	"	Interglacial Peat	3	Mower Co	Drift	" (50 feet below
2375	"	"	Clay (overlying No. 2374)	1	"	"	"
2376	"	"	Blue Clay (overlying No. 2375)	1	"	"	"

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2377	1875.	Geol. Sur	Cretaceous Debris..............................	..	Lime Springs, Iowa....	Drift.. ...	......
2378	"	Z. Haight	Sandstone ["bedrock"]...........................	3	Martin Co............	....	from
2379	"	Geol. Sur	Trenton Limestone	1	Fountain, Fillmore Co	Trenton..	Tay-
2380	Aug. 1875	"	Medina Sandstone.......................	3	Medina, N. Y....	Medina..	......
2381	1875	" . . .	Cretaceous Sandstone	1	Austin.......	Cret.......	......
2382	Aug 1875	"	Waverly Sandstone. [Cut slabs 1x2¼ ft.]........	2	Ohio......................	... .	......
2383	1875.	"	Shakopee Limestone....	1	Olmsted Co...........	Shak....	......
2384	"	"	Potsdam Limestone..............................	1	Hinckley................	Potsdam ..	..... .
2385	"	"	Red Quartzyte	5	Pipestone Co	....	Pipe-
2386	"	"	Calcite	6	Chatfield.................	....	......
2387	"	"	Limestone..	2	Clinton Falls, Steele Co	Trenton..	Ab-
2388	"	"	Limestone...............	2	Montorville, Dodge Co.	Galena....	a ra-
2389	"	"	Limestone..	1	S. side Mantorville, Dodge Co	"	Man-
2390	"	"	Limestone............	2	Mantorville, Dodge Co	"	bank r23...
2391	"	"	Shakopee Limestone...........	1	Northfield.	Shak.......	......
2392	"	"	Limestone.	2	Wabasha Co., nr. sec. 4, Oronoco, Olm. Co	.. ..	bot-
2393	"	"	Limestone.	1	Sec. 8, Oronoco, Olm. Co	Shak.......	......
2394	"	"	Calcite Geodes....................................	1	Sec. 31, High Forest Olm. Co	....	lam's

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2395	1875.	Geol. Sur	Limestone	4	High Forest, Olm. Co.		M. W. Harrington
2396	"	"	Limestone	2	Root River, Olm. Co.	Galena	" A few rods W. of P. Brewers
2397	"	"	Aluminous Sandrock	1	Root River, Olm. Co.	Cret (?)	M. W. Harrington, a few rods E. of P. Brewer's
2398	"	"	Limestone	2	Rochester, Olm. Co.	Galena	M. W. Harrington, one mile E. of P. Brewer's
2399	"	"	Limestone	3	Rochester, Olm. Co.	"	M. W. Harrington, Gar'ck's Q'y
2400	"	"	Stalactitic Forms	Indf	Rochester, Olm. Co.	"	" "
2401	"	"	Limestone	3	Dodge Co.	Trenton	" Conc'd Q'r'y.
2402	"	"	Siliceous Hæmatite	1	3 or 4 ms. west Can. Falls		N. H. Winchell, [In outcrop]
2403	"	"	Sand Concretions	16	Lanesboro, Fill. Co	Jordan	" [See 4th An. Rep.]
2404	"	"	Limestone	3	Cascade, Olm. Co	Trenton	M. W. Harrington, Jackson's Quarry
2405	"	"	Weathered Shale	3	Cascade, Olm. Co.	"	M. W. Harrington, Jackson's Quarry
2406	"	W. W. Folwell	Water Limestone	1	Margaretta, Erie Co., O.	Waterline.	Presented by W. W. Folwell
2407	"	Geol. Sur	Limestone (Rusty)	4	Sec. 31, High Forest, Olm. Co.		M. W. Harrington, Williams' Quarry
2408	"	"	Siliceous Concretion	1	Jordan, Fill. Co	Drift	N. H. Winchell
2409	"	"	Magnesian Limerock (Arenaceous)	1	Bear Creek, Rochester, Olm. Co	Shak	"
2410	"	"	Limestone	1	Sec. 7, Viola, Olm. Co.	Trenton.	"
2411	1876.	Centennial Ex.	Limestone (Drilled by Diamond Drill)	1			Drilled in Machinery Hall, and presented by Diamond Rock Boring Company
2412	1872.	Geol. Sur	Hone-Stone	1	Austin	Cretaceous	N. H. Winchell, manufactured at Austin

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of specimens.	Locality.	Formation	Collector and Remarks.
2455	1872.	Geol. Sur	Cretaceous clay	1	Austin	Cret.	N. H. Winchell
2456	1879.	"	Linomite [after Pyrite]	1	Wabasha	Low Sil.	"
2457	1876.	Jas. D. Hutchinson	Cannel Coal	1	Pennsylvania	Carb.	Presented by Jas. D. Hutchinson
2458	"	"	Talc	1	Vermont		Presented by Jas. D. Hutchinson
2459	"	"	Tellurium	1	Colorado		Presented by Jas. D. Hutchinson. [Humboldt Mine]
2460	"	"	Chalcopyrite	1	Stratford, Orange Co., Vt.		Presented by Jas. D. Hutchinson
2462	"	"	Sand Concretions	2	Sharon, Windsor Co. Vt.		Presented by Jas. D, Hutchinson
2463	"	"	Graphite	1	Chelsea, Orange Co., Vt.		Presented by Jas. D. Hutchinson
2464	"	"	Mica	1	Chelsea, Orange Co., Vt.		Presented by Jas. D. Hutchinson
2465	"	"	Ophiolyte	1	Roxbury, Vt.		Presented by Jas. D. Hutchinson
2466	"	Geol. Sur	Roofing Slate	7	Thomson		N. H. Winchell
2467	"	"	Dendrites on lithographic stone	1	Solenhofen, Bavaria		Presented
2468	"	Minnie Bolles	"Tennessee Marble	1	Tennessee		
2469	Oct. 1876	Geol. Sur	Unio	...	Minneapolis		N. H. Winchell. From the brick-clay
2470	"	"	Planorbis, &c	....	"		N. H. Winchell. From marl overlying brick-clay
2471	"	"	Cretaceous debris	Indf	Hennepin Co	Drift	N. H. Winchell
2472	1876.	A. N. Fuller	Fluorite	1	Silverton, Colorado		From San Juan Mines

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2473	1876.	A. N. Fuller	Argentiferous Galena	1	Silverton Col		From San Juan Mines
2474	"	"	Cubical Pyrites	1	"		" "
2475	"	"	Argentiferous Galena	4	"		" "
2476	"	"	Stephanite ["Brittle Silver"]	2	"		" "
2477	"	"	Quartz [Crystallized]	1	"		" "
2478	1877.	W. A. Brownell	Petrified Wood	4	Near So. Park, Col.		
2479	"	"	Endoceras proteiforme. Hall	2	S. Rutland, Jeff. Co. N. Y.	Utica	
2480	"	"	Graptolite	3	" "	"	
2481	"	"	Triarthus Beckii	2	" "	"	
2484	"	"	Fetid Limestone	1	Gr't. Bend, Jeff. Co., N. Y.	Trenton	
2490	1876.	Centen. Exhibit'n.	Red Hæmatite	2	Athens, Tenn		Presented by the Tennessee Centen. Com
2491	"	"	Red Hæmatite	1	Rockwood, Tenn		Presented by the Tennessee Centen. Com
2492	"	"	Red Hæmatite	1	Riceville, Tenn		Presented by the Tennessee Centen. Com
2493	"	"	Limonite	2	Stewart Co., Tenn		Presented by the Tennessee Centen. Com
2494	"	"	Limonite	2	Johnson Co., Tenn		Presented by the Tennessee Centen. Com
2495	"	"	Limonite	1	Anderson's Sta. N. Ga.		Presented by the Tennessee Centen. Com
2496	"	"	Hausmannite [Manganese, Black oxide, impure]	1	Cooke Co., Tenn		Presented by the Tennessee Centen. Com
2497	1875.	Geol. Sur	Agate	1	High Forest, Olm. Co	Drift	N. H. Winchell
[illegible]	"	"	Limonite		SE. ¼, Sec. 8, Bloomfield, Fill. Co	Cret. ?	N. H. Winchell. From C. C. Temple's well

Catalogue of Specimens Registered in the General Museum in 1878—Contined.

Catalogue of Specimens Registered in the General Museum in 1878.— Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME	No. of Specimens.	Locality	Formation	Collector and Remarks
2516	1876.	Geol. Sur	Brick clay			Drift	N. H. Winchell.
2517	"	"	Crag			"	"
2518	"	"	Calcite			St. Law.	"
2519	"	"	Debris from local drift			Drift	"
2521	"	"	Limonite. [Pseudomorph after Pyrite]			Shak	"
2522	"	"	Limonite. [Pseudomorph after Pyrite]			"	W. D. Belden.
2523	"	"	Fossiliferous chert			"	N. H. Winchell.
2524	"	"	Straparollus			"	Horace V. Winchell.
2525	"	"	Sand concretions			St. Croix	N. H. Winchell
[illegible]	J'ly 13, '78	"	Fossiliferous chert			Drift	N. H. W. [In loam near top of Lower Trenton terrace.]
[illegible]	1876.	"	Fossiliferous limestone [slab].			Trenton	N. H. Winchell.
[illegible]	J'ly 15, '78	"	Sandy loam			Loam	N. H. W. [Near Fox & Perkins mill.
[illegible]	1876.	"	Clay loam			"	N. H. W. [Near Fox & Perkins mill.
[illegible]	"	"	Decaying mica schist			Drift	N. H. Winchell.
	"	Centennial Exb.	Limonite				Selma, Rome & Dalton R. R.
	"	"	"				" "
	"	"	Limestone				" "
	"	"	"				" "

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2536	1876.	Centennial Exb	Iron ore	1	"Amberson's," Ala		Selma, Rome & Dalton R. R.
2537	"	"	Peacock Copper ore	1	Stone Hill, Ga.		" "
2538	"	"	Charcoal	1	Stonewall, Ga		" "
2539	"	"	Pine Charcoal [made in ovens]	2	Shelby Furnace, Ala		" "
2540	"	"	Magnetite	Indf	Port Henry, N. Y		From the New Bed Mine
2541	"	"	Barite	1	Mineral Point, Wis	Galena	Wisconsin Geol. Sur
2542	"	"	Linomite	2	Nr. Chattanooga, Tenn.		Tenn. Commissioners
2543	"	"	Linomite, [bog ore]	2	Vernon Co., Wis	"Potsd'm"	Wisconsin Geol. Sur
2544	"	"	Smithsonite	1	Mineral Point, Wis.	Galena	" "
2545	"	"	Fossiliferous Hæmatite	3	Mayville, Wis	Clinton	" "
2546	"	"	Serpentine rock	1	Near Philadelphia, Pa		The University of Penn. is built of this
2547	"	Geol. Sur	Dressed limestone	1	Rochester, Minn	Trenton	Presented by W. D. Hurlbut
2548	"	"	Dressed Kasota stone	2	Kasota	Shakopee	Presented by Downs Bros
2549	"	"	St. Lawrence limestone	....	St. Lawrence	St. Law	N. H. W., filled with greensand
2550	"	"	Limestone boulders	1	"	Drift	"
2551	"	"	Quicklime	Indf	"	"	" burnt from No. 2550.
2555	"	"	Cretaceous debris	"	Minnetrista, Hennepin Co	"	"
2556	"	Centennial Exb	Washed Kaolin	"	Grand Rapids, Wis	Laurent'n.	Wisconsin Geol. Sur
2557	"	"	Unwashed Kaolin	"	" "	"	" "
2558	Aug. 1877	Geol. Sur	St. Peter Sandstone	1	St. Paul, [Dayton's bluff]	St. Peter	N. H. W., eaten by lithodomous molluscs
2559	1877.	"	Limestone	1	St. Andrew's Rapids, Manitoba		N. H. W., 12 miles below Winnipeg
2560	June 1877	"	Selenite [crystals]	Indf	Fort Abercrombie, Dak		N. H. Winchell
2562	Aug. 1877	"	Fossiliferous slabs	"	St. Paul	Trenton	"

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2587	1872.	J. W. Pomeroy....	Pyrite....	1	Gold Hill, Colorado...	....	Presented by J. W. Pomeroy..
2588	"	"	Pyrite in grit.	1	" "	....	" " ..
2589	1877.	Geol. Sur........	Potter's clay....	Indf	Section 3 Goodhue, Goodhue Co.......	....	N. H. Winchell.... ...
2590	"	"	Terra-cotta clay....	"	Red Wing, Goodhue Co	....	" ....
2591	"	"	Green sand....	"	" "	St. Croix..	" ....
2592	"	"	Green sandstone.	2	Hay Creek, Goodhue Co	" ..	" ....
2594	"	"	Organic forms[?]....	7	Soren's bluff, Red Wing	St. Law...	" ....
2598	Nov, 1876	Geo. F. Kunz.....	"Clay stones"....	Indf	Franklin, N. J	....	....
2599	"	"	"	"	Long Meadow, Mass...	....	....
2600	"	"	Talc....	3	Staten Island, N. Y....	....	....
2601	"	"	"Horse bone Tufa"....	2	Watertown, N. Y.....	Drift.....	....
2602	"	"	Waterline cement rock....	1	Rondout, N. Y........	Silurian...	....
2603	"	"	Shales.	5	Catskill Falls, N. Y....	" ..	....
2604	"	"	Compact, massive sphalerite....	1	Bethlehem, Pa....	....	....
2605	"	"	Trap dyke in gneiss....	1	Mt. Tom, Mass........	Igneous...	....
2606	"	" ...	Quartzyte Conglomerate....	9	Morristown, N. J.....	....	....
2607	1877.	Geol. Sur........	Siliceous concretions in sandrock....	1	Goodhue Co........	St. Croix..	N. H. Winchell.... ....
2608	1873.	A. F. Lounsberry.	Silicified wood....	5	Bismark, Dak........	....	Presented by A. F. Lounsberry
2609	"	" ..	Gypsum....	10	"	Cretaceous	" "
2610	"	" ..	Lignite....	6	"	"	" "
2611	"	" ..	Slag [from burning of lignite]....	2	"	....	" "
2612	1876.	" ..	Quartz gangue with chalcopyrite. [No. 29].....	1	Kellogg Mines, Pulaski Co., Ark.....	....	Little Rock & Fort Smith R. R.
2613	"	W. E. Rowell......	Sulphide of lead. [No. 30]....	1	Kellogg Mines, Pulaski Co., Ark.....	....	" "
2614	"	"	Galenite and sphalerite in slate. [No. 31].......	1	Kellogg Mines, Pulaski Co., Ark.....	....	" "

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2615	1876.	W. E. Rowell	Zinc Blende. [No. 32]	1	Kellogg Mines, Pulaski Co., Ark		Little Rock & Fort Smith R. R.
2616	"	"	Chalcopyrite with sulphuret of silver and siderite. [No. 33]	1	Kellogg Mines, Pulaski Co., Ark		" "
2617	"	"	Spathic iron. [No. 34]	1	Kellogg Mines, Pulaski Co., Ark		" "
2618	"	"	Magnetic iron ore. [Nos. 35 and 36]	2	Magnet Cove, Ark		" "
2620	"	"	Linomite. [No. 37]	3	Pope County, Ark		" "
2621	"	"	Slate ore. [No. 38]	1	Franklin County, Ark		" "
2622	"	"	Carb. of iron. [No. 39]	1	Sebastian County Ark		" "
2623	"	"	Kaolin. [No. 40]	1	Pulaski County, Ark		" "
2624	"	"	Novaculite. [No. 41]	1	Hot Springs, Ark		" "
2625	1877.	Geol. Sur	Subsoil		Sec. 28, Beaver Cr'k, Rock Co., Minn	Drift	N. H. Winchell
2626	Oct. 25, '77	"	Drift clay		Sec. 28, Beaver Cr'k, Rock Co., Minn	"	N. H. Winchell. [40 feet below the surface]
2627	1877.	"	Surface clay		Sec. 28, Beaver Cr'k, Rock Co., Minn	"	N. H. Winchell
2628	"	"	Subsoil [loam]		Sec. 28, Beaver Cr'k, Rock Co., Minn	"	"
2629	"	Dr. J. C. Rosser	Petrified wood. [Bored by Teredo?]	1	Dakota		Presented by Dr. J. C. Rosser
2630	"	"	Fossiliferous concretion. [Inoceramus, &c]	1	"	Cretaceous	" "
2631	"	"	Calcite. [Group of crystals]	1	From a cave near Deadwood, Dak		" "
	pt. 1877	Geol. Sur	Limestone. [The building stone layers]	Indf	Minneapolis	Trent.	N. H. Winchell
	v. 1876	Geo. F. Kunz	"Trap crystals"	6	Bergen Hill, N. J	Igneous	
	1877.	Hugh T. Douglas	Brown hæmatite. [Nos. 1, 2, 3, 4—A]	Indf	Warren Co., Va	Silurian.	Presented by Hugh T. Douglas

Catalogue of Specimens Registered in the Generat Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2635	1877.	Hugh T. Douglas	Trenton limestone	2	Warren Co., Va	Trenton	Presented by Hugh T. Douglas
2636	"	"	Talcose slate	2	Farquier Co., Va	Huronian	" "
2637	"	"	"Syenite"	2	"		" "
2638	"	"	Greenstones	2	"		
2639	"	"	Magnetic iron ore	5	"		Presented by Hugh T. Douglas. From surface of Lodestone Ridge
2640	"	"	Magnetic iron ore	1	"		Presented by Hugh T. Douglas. From Slater's mine
2641	"	"	Calcacrous tufa	1	Clark's Co., Va		Presented by Hugh T. Douglas. Near Shenandoah river
2642	"	"	Calcareous tufa	1	"		Presented by Hugh T. Douglas. 3 miles below Berry's Ferry
2643	"	"	Magnetic and specular iron ore	2	Lodestone Ridge, Farquer Co., Va.		Presented by Hugh T. Douglas. From Slater's Mine
2645	"	"	"Jaspery Rock"	2	Lodestone Ridge, Farquer Co., Va.		Presented by Hugh T. Douglas
2646	"	"	Jaspery hæmatite. [Said to contain Magnetite and Chromium	2	Lodestone Ridge, Farquer Co., Va.		Presented by Hugh T. Douglas. From surface at Slater's Mine
2647	"	"	Jaspery iron ore	1	Blue Ridge, Warren Co., Va		Presented by Hugh T. Douglas
2648	"	"	"Decomposing Rock"	1	Warren Co., Va		Presented by Hugh T. Douglas. Foot hills of Blue Ridge, 5 miles S. of Front Royal

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2667	1877.	Geol. Sur.	Pyritiferous blue limestone. [No. 3]	1	Rice Co.	Trenton.	L. B. Sperry. Deeper strata of the Trenton.
2668	"	"	Trenton limestone. [No. 4]	1	Sec. 9, Wheeling, Rice Co.	"	L. B. Sperry. Prairie Creek quarry.
2669	"	"	Fucoidal argillaceous deposit. [No. 5.] Combustible.	1	Sec. 9, Wheeling, Rice Co.	"	L. B. Sperry. Prairie Creek quarry. [2 in. thick]
2670	"	"	Crag. [No. 6]	1	Ravine nr Asylum, Faribault.	Drift.	L. B. Sperry.
2671	"	"	Iron stained St. Peter sandstone. [No. 7]	Indf	Faribault.	St. Peter	"
2672	"	"	Blue clay, deep subsoil. [No. 8]	"	Eastern part of Rice Co	Drift	
2673	"	"	Prairie loam. [No. 9]	"	" "	"	
2674	"	"	Blue clay. [No. 10]	"	Western part of Rice Co	"	
2675	"	"	Yellow sandy clay. [No. 11]	"	" "	"	
2676	"	"	Soil. [No. 12]	"	Eastern part of Rice Co	"	
2677	"	"	Consolidated blue clay. [No. 13]	"	Sec. 8, Forest, Rice Co.	"	
2678	"	"	Lignite. [No. 14]	"	W. part of Rice Co.	"	
2679	"	"	Drift. [No. 15]	"	S. W. part of Rice Co	"	
2680	"	"	Fragment of boulder. [No. 16]	1	Near Cannon Falls, Rice Co.	"	L. B. Sperry.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2681	1877.	Geol. Sur	Slate	5	Little Falls, Morrison Co.	Huronian	N. H. Winchell
2682	"	"	Concretions in the slate	4	Little Falls, Morrison Co.	"	"
2684	"	"	Mica schist	1	Little Falls, Morrison Co.	"	"
2685	"	"	Mica schist	1	Near Little Falls, Morrison Co.	"	" Mouth of Little Elk river
2688	Sept. 1877	"	Staurolite	Indf	Pike Rapids, Morrison Co.	"	N. H. Winchell
2689	"	"	Staurolite mica schist	22	Pike Rapids, Morrison Co.	"	" Near the mouth of Swan River
2690	"	"	Quartzyte? From the slate	2	Pike Rapids, Morrison Co.	"	N. H. Winchell
2691	"	"	Orthocerata	Indf	Wanamingo, Goodhue Co.	Trenton	"

APPENDIX A.

The following are the full instructions of the Executive Committee given to Prof. Peckham, after amendment so as not to come into conflict with the plans of the State Geologist. The specimens gathered during the progress of the examinations of Prof. Peckham, tendered to the General Museum by him in his report, were subsequently otherwise disposed of by him, and have never been placed in the care of the Curator.

Resolved, That Prof. S. F. Peckham be instructed to proceed as soon as possible after the first of June next, and by the cheapest conveyance, to Grand Portage, Minn., and establish there an assay office, in the best accommodations that he can secure, to remain until about September 1st.

He shall use such apparatus as the University now possesses, and shall procure, in addition, such apparatus as may be necessary.

He shall assay any ores that may be brought to him, requiring in all cases pre-payment of the following named sums: for any number of assays less than three (3) four dollars each; for three (3) assays for the same party and at the same time, ten dollars; for four (4) or more assays for the same party at the same time, three dollars each.

Any parties who will make affidavit that they are citizens of the State of Minnesota, and that their ores are found in Minnesota, giving the locality where the ores were found, as nearly as possible, and certifying their willingness that the results may be published, shall be charged one-half the above mentioned prices. Specimens submitted by the State Geologist, shall be assayed free of cost to private parties, and a report of the same and all other assays and investigations, not for private parties, shall be made direct to the State Geologist.

Payment for assays may be made in specimens of minerals or ores at Prof. Peckham's valuation.

Prof. Peckham shall advertise in the St. Paul Pioneer Press and in the Duluth ——— immediately, and about May 20th, that he intends to go to Grand Portage, and shall also procure the printing of fifty posters, which he shall cause to be posted in conspicuous places in Minneapolis, St. Paul and Duluth.

On his return, he shall make a report to the President of the University, for this committee, in which he shall show all receipts and disbursements made for the University, with any other information that he may consider of value to this committee.

He shall secure the services of Mr. Bowman as his assistant, at a rate not to exceed thirty dollars per month and his expenses.

The sum of two hundred dollars, or so much of it as may be necessary, is hereby appropriated for the use of Prof. Peckham in providing additional apparatus, and such miscellaneous expenses as may be necessary.

Specimens gathered in the course of these examinations, shall be placed in the General Museum, but a series suitable to the Museum of Technology, may be placed there after the General Museum has been supplied.

APPENDIX B.

MICROSCOPIC ENTOMOSTRACA,

BY C. L. HERRICK, *Laboratory Assistant.*

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NEW HAVEN, JANUARY 8, 1879.

Prof. N. H. Winchell:

DEAR SIR: I have examined the chapter by Mr. Herrick, which you placed in my hands, and think it a valuable contribution to science. It will make a very appropriate addition, it appears to me, to the Minnesota State Report, because of its illustrating with well-drawn figures and good descriptions the life of the fresh water of the State. The species are among the most interesting of the minuter animals of the waters, and have a wide distribution over the globe.

Yours truly,

JAMES D. DANA.

MINNEAPOLIS, MINN., JANUARY 14, 1879.

Gen. H. H. Sibley, President of the Board of Regents:

I herewith communicate to the Regents an illustrated memoir on the microscopic crustaceans of fresh waters of Minnesota, as a contribution on the Natural History of the State, in accordance with law. This valuable paper, by Mr. C. L. Herrick, my laboratory assistant, has cost the Survey nothing more than the use of its rooms and apparatus, and has been submitted to the approval of Prof. J. D. Dana of New Haven, who indorses it as a valuable contribution to science, and recommends its publication.

Very respectfully,

N. H. WINCHELL.

It is with the hope that the following paper may be of service to some who, like myself, were interested in the many and varied forms found in every stagnant pool as well as in the lakes and ponds of our country, but who were unable to find any connected account of them, that it is offered to such, as a contribution toward a better understanding of a little known order of the natural kingdoms.

The lakes within a radius of ten miles of Minneapolis have furnished all the material examined, and the supply is not exhausted by any means. It is only hoped to so outline the extent and limits of this division of animal life that it will be less difficult to place the forms found from time to time, in approximately their true position.

With very few exceptions, as far as has been ascertained, no one has devoted any attention to the fresh water *Entomostraca* of America, and it is necessary for some one to act as a pioneer, to learn whether any of the forms described in Europe appear here, and to discover, if possible, if there be a general similarity between these widely separated faunæ. This has been the ambition of the present writer; and if only an intelligent attention be directed to this field, he will feel abundantly repaid for the attempt.

The works consulted were Dana's "Report of the Crustaceans collected during the Wilkes Exploring Expedition to the Pacific Ocean", Dr. W. Baird's "British Entomostraca," "Report of U. S. Fish Commission," papers in "Hayden's Survey of the Territories", and papers in the American Naturalist and other periodicals. Many thanks are due to Prof. N. H. Winchell, director of the State Geological Survey, for assistance and advice in many ways; to President W. W. Folwell, and Dr. P. L. Hatch, for assistance and intelligent sympathy, and to fellow members of the "Naturalist's Club."

That there will be found mistakes in the work is to be expected, but it is hoped that the information will be reliable in the main.

It is not without hesitation that, as a novice in scientific investigation, names are suggested for the new species found, but the purpose of this paper will be best served by defining as well as possible these forms, and submitting them to the test of further study; and if in the future more experience and greater research can be brought to bear upon this domain, these preliminary notes will perhaps not be without their value. The drawings were all made by the writer, in most cases from life, though some details have been introduced from the works consulted, and the plate of *Phyllopoda* was collected from the government reports and elsewhere. Clearness in outline and detail rather than beauty in execution was the desideratum.

C. L. HERRICK.

INTRODUCTION.

ENTOMOSTRACA.

The name was derived from two Greek words meaning insect and shell, by Otho F. Muller, and applied by him in his "*Entomostraca*" (1785) to the animals which had hitherto been all comprised in Linnæus' genus *Monoculus*, named from the supposition that they all possessed but one eye. The name "*Branchipodes*" was also proposed, and would have been appropriate enough, but Muller supposed that the branchial appendages which suggested the name, were wanting in *Cythere*, etc. Muller, aside from naming the group, was the first to arrange these animals in anything like a systematic classification, and collected a great deal of interesting information. Since his time several authors have written upon these interesting animals in Europe, but with a few exceptions no systematic work on Entomostraca has appeared in English.

Dr. W. Baird published in 1850 a superb work on the Entomostraca of Great Britain, which is still the best thing in the English language. But since this work was published, many additions have been made to our knowledge. In Prof. J. D. Dana's magnificent work on the Crustacea found in the "Wilkes Exploring Expedition", many new species are described, and a revised classification for the whole order is proposed. In this work every known genus was characterized. Since then additions of new species have been published by various authors, and are scattered through the reports of various societies. Moreover, recent studies in Embryology have thrown new light on the classification of all the lower animals, and many changes are necessary, but it is not possible at this stage of the study to attempt a

SYSTEMATIC ARRANGEMENT

of this order. We shall follow quite closely Dana's system as being most complete.

The following changes, which will not affect essentially the nomenclature used must be indicated as the necessary result of modern research:

1. The *Merostomata*, or King Crab group, which contains the modern genus *Limulus* (Horseshoe Crab) and the ancient *Eurypteridæ*, etc., which was considered by Dana a sub-order of Entomostraca has by recent writers been regarded as a distinct order intermediate between the *Trilobita* (which Dana included with the sub-classes *Chorestopoda* and *Entromostraca* in the class *Edriophthalmia* or *Tetradecapoda*) and the *Entomostraca*.

Trilobita now stands at the foot of the sub-kingdom, its inferiority in rank being assumed from the inferiority in point of time.

The *Cormostomata* (including *Pæcilopoda* or *Epizoa*) has been uni *Copepoda* (*Cyclopacea*) thus doing away with the sub-orders in Entom

The *Pectostraca* (including *Phizocephala* and cirripeda (barnacles) have been assigned a place among the Entomostraca from facts learned regarding their development. These crustaceans have been tossed from one division to another till they ought, it would seem, to find a permanent resting place. First considered mollusks, they have now taken their position among the lower crustaceans. These creatures, which are at maturity firmly cemented to foreign bodies, and are inclosed in a hard shell-like test have, in their earlier stages, forms resembling the "Nauplis" stage of *Cylops* (see plate III.) and also a stage resembling the mature *Cypris*.

It is now known that, as Huxley expresses it, "the barnacle is a crustacean fixed by its head and kicking its food into its mouth." The attachment of the head finds a parallel in the genus *Sida* (see beyond), which contains animals that can attach themselves at will to bodies by a sucker-like disk on the head, corresponding to the pedicle of the barnacles. As the barnacles and epizoa have not been observed no further mention will be made of them in this connection.

The following table from Huxley's Anatomy of Invertebrates will perhaps be useful for reference.

(Articulates or)

ARTHROPODA.

I.

Without manducatory appendages *(Gnathites)*

Trilobata. Tardigrada (?) Pentastomida(?)

II.

With pediform gnathites.

Merostomata. Arachnida. Peripatidea.

III.

With maxilliform gnathites.

Entomostraca. Myriapoda.
Malacostraca. Insecta.

Water-breathers. Air-breathers.

For the most part.

The extent of the *Entomostraca* has been outlined above, and the *Malacostraca* includes the remainder of the crustaceans, viz: those included by Dana under *Podophthalmia* and the order *Choristopoda* of *Edriophthalmia*, thus embracing crabs, shrimps and all the higher crustaceans, whose body consists (almost always) of twenty segments (somnites) of which six constitute the head, and bear, respectively, the eyes, superior antennæ, inferior antennæ, mandibles, and two pair of maxillæ. Of the remaining somnites eight pertain to the thorax, and carry the foot jaws and walking limbs, while six are abdominal and bear swimming limbs. These higher forms do not go through the Nauplius stage in their development, as do the *Entomostraca*.

GENERA CHARACTERS OF ENTOMOSTRACA.

The Crustaceans of this order are quite various in form, habits and internal structure. They possess specialized jaws, but there are never more than three pairs of qualities, while in the higher orders there are often six.

The somnites of the abdomen (that portion of the body posterior to the genital aperture) are devoid of appendages. Though the study of these animals is very fascinating and instructive the task is a difficult one, both on account of the minute size of most of them and the great difficulty of ascertaining with what organs of the higher forms some of the novel instruments seen are homologous. The curious misapprehensions and inaccuracies into which authors have fallen still further complicates the matter.

The descriptions of these organs, and their functions, must be taken up under the divisions of the order and treated separately. The process of reproduction is particularly interesting in this group, for we have numerous instances of agamogenesis and the *Pectostraca* are hermaphrodites peculiarly modified Alternate generation will be spoken of more particularly under the *Daphnioidæ*. The species described have all been collected and compared with descriptions of previous authors, the new species, it is hoped, will be found sufficiently well defined in connection with the figures given to permit of a ready identification.

The following table of the families of the order will be useful for reference, while the characters upon which they are founded, and synonyms, will be found in their appropriate places.

TABULAR VIEW OF ENTOMOSTRACA.

ORDER ENTOMOSTRACA.

LEGION I. LOPHYROPODA.

TRIBE I. CYCLOPOIDEA (here used as equal to *Copepoda* with the *Pœcilopoda* among he *Cormostomata* (or *Epizoa.*)

Family 1. Calanidæ.
Family 2. Cyclopidæ.
Family 3. Corycaidæ.
Epizoa?

TRIBE II. DAPHNIOIDÆ. (Cladocera.)

Family 1. Penilidæ.
Family 2. Daphnidæ.
Family 3. Bosminidæ.
Family 4. Polyphemidæ.

TRIBE III. CYPRIDÆ.

Family 1. Cypridæ.
Sub-family a. Cyprinæ. (Cypridæ Bd.)
Sub-family b. Cythrinæ. (Cythridæ Bd.)
Family 2. Halocypridæ.
Sub-family a. Cypridininæ. (Cypridinadæ Bd.)
Sub-family b. Halocyprinæ.

LEGION II. PHYLLOPODA.

TRIBE I. ARTEMIOIDEA.

Family 1. Artemiadæ. (Branchipodidæ.)
Family 2. Nebaliodæ.

TRIBE II. APODIDÆ.

Family 1. Apodidæ.

TRIBE III. LIMNADIOIDÆ.

Family 1. Limnadidæ.

Note—Other genera have been added to those given by Dana, and changes made. The family Estheriadæ seems, however, to be equivalent to Limnadidæ.

LEGION I. LOPHYROPODA.

Bibliography.—Lophyropa, *Latreille*, Cuv. Regne An., 1677;
Lophyropoda (in part), *Leach*, Dict. Sci. Nat., XIV., 554.
———— ——— *Gray*, Cat. Brit. Crust. Brit. Mus. 1850, 100.
———— ——— Baird Brit, Entomost., 138.
Cranchiopodes franges (in part), *Lamark*, Hist. Ans. Vert.

Characters.—Feet normal and not greatly multiplied in number.

TRIBE I. CYCLOPOIDEA.

Bibliography.—Carcinoida (in part), *Latreille*.
Copepodes, *Edwards*, Crust., iii., 411.
Copepoda, *Baird*, Trans. Berw. Club, ii., 1875.
———— Baird, Brit. Entomost., 182.
Cophyropoda, *Burmeister*, Organiz. of Trilobites.
Copepodita, *Gray*, Cat. Brit. Crust. Brit. Mus., 1850.
Crustacea copepoda (Cyclopacea), *Dana*, Proc. Ardes. Acad. Sci. and Art., 1847.
Cyclopoidea, *Dana*, Rep. Wilkes' Exp. Ex., p. 1020.

Characters.—Body elongate, straight, never incurved. Cephalothorax and abdomen with few joints. Feet and jaws 16 to 18. The 6–10 posterior thoracic feet are double, foliacecus, with the last often prehensile.

This is a very extensive and widely distributed division, and there is a greater unity of plan seen in the structure of the animals comprised in it than in other divisions of similar importance. These creatures are distributed over the world, in both fresh and salt water, and the numbers may doubtless be reckoned by thousands, but little attention has been devoted to the subject, and our knowledge is quite meagre.

The Cyclopoidea are considered the highest group in the order, approaching the Macroural Crustaceans. The body is not covered by a carapace, as in the following tribes, and the abdomen is extended in the same line as the body, and not incurved as in Daphnioidea, etc. The abdomen is terminated by two stylets which bear several setæ. If the Epizoa are to be admitted into this tribe, certain modifications would be necessary, which we need not discuss.

The cephalothorax is composed of from four to seven segments. In those species having four segments, the first bears the first and second antennæ, mandibles, maxillæ, maxillipods, first feet and one pair of natatorial feet, while the following three carry the remaining pairs of natatores.

Eyes of the three kinds: 1. A pair of simple internal eyes with spherical lenses, which are the ordinary kind. These are usually united near the front in a single very small spot, though they are sometimes remote.

2. A pair in an elevation on the under side of the head between the antennæ. The pigment is often like a piece of solid indigo.

3. A pair of simple eyes consisting of an internal prolate lens situated at the extremity of a vermiform mass of pigment and of a large oblate, lens-shaped cornea. This kind of eye is found in the Corycæidæ.

Antennæ. The antennæ are of two pairs, of which the superior are organs of locomotion, and usually are long and powerful. In the males of many species one or both are modified to form a joint by which the female is held during coition. These modifications are often of generic importance.

The secondary antennæ are subjected to greater changes and serve various functions. Sometimes they are simple; in other species they have two rami. They are often prehensile, and when simple the setæ at the end are movable so that they assist the animal to creep on surfaces.

The mouth is situated in the posterior aspect of a low prominence beneath the head.

The mandibles are variously modified.

The maxillæ are one to four jointed organs.

The maxillipeds are always simple, or if divided the branch is rudimentary.

Anterior pair of legs (or *second maxillipeds*). These organs vary greatly in form, and afford means of generic classification, and will be described under their appropriate heads.

Natatory feet. These are similar to those of other Entomostraca, bearing setæ for locomotion. There are four pairs, and sometimes a prehensile or abortive pair following.

The heart is situated in the posterior part of the thorax, and the circulation may be watched as the blood globules circulate between the tissues; particularly in some transparent species of Calanidæ these may be well traced in the thorax.

Nervous system. A large ganglion exists over the mouth, and surrounds the œsophagus.

This tribe includes three families, as given by Dana, but the Epizoa must probably be included also. The family *Corycæidæ* is oceanic, and no members have been found in our locality.

FAMILY I. Calanidæ.

Bibliography.—Dana, Wilkes' Explor. Ex,. p. 1039.

Characters.—Eyes often of two kinds, the upper pair being simple and minute, with their pigments either separate or collected into one. In

some species there is another pair beneath, with joined pigments. Mandibles and maxillæ elongate, carrying a palpus, which is furnished with setæ. Ova sac one. First pair of antennæ long, unappendaged; the right or neither having a geniculating joint. Feet of the first pair never sub-prehensile at the end.

The Calanidæ are divided into three sub-families, only one of which has been found to be represented in our locality, however, the classification will be indicated.

SUB-FAMILY 1. CALANINÆ.—Abdomen of moderate length, inferior pair of eyes wanting. Right superior antennæ of male without a geniculating joint. Secondary antennæ setigerous at the end.

Genus 1. Calanus, *Leach, Dana.*
Genus 2. Rhincalanus, *Dana.*
Genus 3. Cetochilus, *Goodsir.*
Genus 4. Euchæta, *Philippi.*
Genus 5. Undina, *Dana.*

SUB-FAMILY 2. OITHONINÆ.—Abdomen linear produced, scarcely shorter than the cephalothorax. Inferior eyes wanting. Maxille digitate on the interior margin. Superior antennæ long, few-jointed; right male antenna not geniculate nor movable in an angle.

SUB-FAMILY 3. PONTELLINÆ.—Abdomen of moderate length. Eyes sometimes of two kinds. Antennæ long and, in all the genera but *Acartia*, having a geniculating joint. Second antennæ setæ-bearing at the end. Posterior feet of the male thick; the right prehensile.

Genus 1. Diaptomus, *Westwood.*
Genus 2. Hemicalanus, *Dana.*
Genus 3. Candace, *Dana.*
Genus 4. Acartia, *Dana.*
Genus 5. Pontella, (*Pontia, Edwards*).
Genus 6. Catopia. *Dana,*

Genus Diaptomus, Westwood.

Bibliography.—Monoculus, *Linnæus, Fabricius Jurine,* etc.
Cyclops, Muller, *Desmarest, Manuel,* etc.
Diaptomus, *J. O. Westwood,* Partington's Cycl. Nat. Hist., Entomologist's Text-book, 1838.
——— *W. Baird,* Brit. Entomost., p. 219.
——— *J. D. Dana,* Rep. Wilkes' Expl. Ex., p. 1045.
Cyclopsina, *M. Edwards,* 1840.
——— *Philippi,* 1843.
——— *Baird,* Zoologist, i. 56: Trans. Berw. Clarb.
——— *Dana,* Proc. Amer. Acad. Art and Sci.
Omethina, *Templeton,* Trans. Ent. Soc., ii., 118, 1838.
Broteas, *Loren,* Kongl. ret. Akad. Handl., 1845, p. 436.

Characters.—The smaller ramus of the secondary antennæ six to seven jointed. Maxillipeds scarcely less, often larger than the first pair of feet. Posterior pair of feet in the male thick, the right prehensile, those of the female long and different from the preceding pairs. Ova sac one.

Of the two species here described, one is certainly a member of this genus, while the other is in many respects more like Dana's genus *Hemicalanus*, which differs from *Diaptomus* in not having the posterior feet of the female large and stout and the shorter branch of the secondary antennæ without the numerous joints. The species of *Hemicalanus* are also oceanic. and none were seen to have ova sacs. Both our species have single ova sacs, while one is not evidently furnished with the plurality of articulations to second antennæ. Not having given a full account of the family, it may be well to incorporate a more general with the technical description. These animals are usually small, seldom reaching one-fourth of an inch, but commonly appearing as mere specks in the water. The body is canoe-shaped, and divided into two portions. The main portion, or cephalothorax, is usually much the longest. The antennæ are the organs of locomotion, being used as oars in the same manner as the "water-boatman," etc., use the feet. The posterior pair of feet vary with the sexes, as described above, the four following pairs are swimming organs, while the anterior pair are modified and turned forward.

The cephalothorax is more often seven jointed in *Pontellinæ* than in the *Calaninæ* but this is not a constant character.

Diaptomus longicornis, Herrick.*

This speccies is very near to *D. castor* and may, indeed, be a variety of that species, it differs, however, in shape and color from figures of that species, and the maxillæ, and antennæ differ considerably. Cephalothorax rather long, narrowly oval, six-jointed; superior antennæ, rather long but they are not curved as represented in Dr. Baird's figures of *D. castor*. The male right antenna has a geniculating joint at the thirteenth segment which is armed with a considerable curved spine; the joints following are more or less enlarged and sometimes coalesce, forming in extreme cases a monstrosity as represented in Geol. and Nat. Hist. Rep. for 1876. The secondary antennæ are two branched, the outer ramus being three-jointed and armed at the extremity with three curved spines, forming a sort of hand, the middle segment also bears a number of setæ on the inner margin, the minor ramus is six or seven-jointed, though it appears three-jointed at first, the middle segment being sub-divided. The head is produced into a beak in front but it is much smaller than in the following.

The maxillepedes (or first pair of feet) are of three portions, the latter two bearing setæ which are directed towards the head, the final division is composed of about six small joints each bearing a tuft of the sete. The remaining pairs of feet are alike, each having two setigiferous rami. In the female the fifth pair of feet are prehensile and stout, those of the male are unlike, the right being long and the other rudimentary.

This species is very brilliantly colored, the tips of the antennæ and last segments of the abdomen are a fine bluish purple, while the body is variegated with red, yellow and purple. The mass of eggs is also a beautiful red. Only one locality is known to contain the creature, though it may be abundant in the more marshy pools. In the Rep. of the Geol. Surv. of Minn. for 1878 it was mentioned and a figure given, but erroneously called cyclops. (See plate I.)

*See D. sanguineus, *Forbes* in Ill. State Mus. Rep. 1876. The description differs, apparently, in several respects, notably as to color, but the species is cerainly closely allied.

Diaptomus pallidus, Herrick.

A more abundant form than the above, though less striking in appearance, is the creature for which this name is suggested. The cephalothorax is more elongate and has but five segments. The antennæ are much longer, considerably exceeding the body in some specimens. The joints of the antennæ following the geniculating joint are not united or modified, neither is there an appendage to the segment immediately preceding. The whole body is slender and graceful, resembling *Hemicalanus* but the fifth pair of feet is not obsolescent. The secondary antennæ were not noticed to have the multiplied intermediate oints in the minor ramus, but such may be the case.

This animal abounds in the larger lakes, and seems to prefer pure water, while the other is found in more stagnan twater. These creatures are not found infested by bell animalcules and desmids as is the cyclops, probably from their rapid motions and the nature of their haunts.

D. pallidus may be at once distinguished from *longicornis* by its lacking the brilliant coloring of the other, it being quite colorless, and by its smaller size.

D. longicornis is 65-1000 inch in length, while the species in question rarely exceeds 40-1000 inch. The eye in this species is also less conspicuous. (See plate II.)

FAMILY II. **Cyclopidæ.**

Bibliography.—Dana, Rep. Wilkes' Exp. Ex., Vol. XIV. Part 2, p. 1039.

Characters.—Eyes small, simple, usually with united pigments. Mandibles with a small or obsolete palpus and few setæ. Ova sacs one or two. Primary antennæ, often appendaged. Both or neither of the male antennæ geniculate. Feet of the first pair more or less prehensile at the end.

The prehensile character of the first pair of legs is chosen by Dana as the chief characteristic of the family; these organs sometimes being perfectly prehensile, with a perfect monodactyle hand, which never occurs in Calanidæ. These animals often possess appendages to the first and second segments of the abdomen, as see plate of *Canthocamptus.*

The cephalothorax has little variation in structure, having either four or five segments. The anterior antennæ are more often much shorter than the body, and if either of them is modified in the male, both of them have a geniculating point. The abdomen is five or six jointed, and may or not be abruptly smaller than the cephalothorax, which fact forms a basis for generic distinction.

The genus Cyclops possesses two ova sacs, while the ren aining genera, so far as known, have but one. This leads to the division of the family into the two leading sub-families. The third sub-family is founded by Dana upon some sapphirina-like species of doubtful affinities, described by H. D. S. Goodsir.

Sub-family 1 Cyclopinæ, Dana.

Characters.—Ova sacs two.

Genus 1. Cyclops, *Muller.*

? Genus 2. Cyclopina, *Claus**

*There are a considerable number of genera of the following sub-families, etc., mentioned in Claus' "Zoologie", which are, for the most part, not described. Since I have not been able to consult the works in which they are defined, and since he seems not to recognize many of those described by Dana, and to disregard his classification, the deciphering of their relation and situation will not be attempted here.

? Genus 3. Psammathi, *Philippi*, Archiv. fur Naturgeschicte.
? Genus 4. Idomene, *Philippi*, " " "
? Genus 5. Euryte, *Philippi*, " " "

GENUS 1. Cyclops.

Bibliography.—(See Cyclops quadricornis.)

Characters.—Cephalothorax four-jointed. Anterior antennæ of the female not appendaged; of the male both geniculate. Appendage at the base of abdomen small. Body sub-cylindrical. Feet of the first pair didactyle.

The various species of this genus are found in inland waters the world over, being essentially fresh water animals, in a few cases only inhabiting water a little brackish. They are among the most abundant of all the individuals of the order, every standing pool abounding in them; they are also extremely variable both in different stages of the same animal, in the different sexes and in different localities.

The young stages of Cyclops have been named as distinct species, in so far that the same animal has been honored with three or four different titles between birth and maturity. In our own locality many forms have been found, and it is quite likely that careful study would enable us to distinguish several species and numerous varieties, but such is the extreme variability of the one known to exist here, that it is not now possible to draw a dividing line between the varying forms, so that all that is attempted is to give a general view of the species, and leave further definition for more minute investigation.

Cyclops quadricornis, Muller.

Bibliography.—Monoculus quadricornis, *Linnæus*, *Gmelin*, *Scopoli*, *Fabricius*, *Jurine*, *Sulzer*, *Donovan*, *Blumenbach*, *Manuel*, *Barbut*, *Shaw*.
Monoculus apus, *Poda*.
Le Monocle à querie fourchue. *Geoffroy*.
Le Monocle à quatre cornes. *De Geer*.
Cyclops quadricornis, *Muller*, Zool. Dan. Prod., 2416, 1776.
——— *Ramdhor*, *Latreille*, *Box*, *Lamarck*, *Baird*, *Leach*, *Koch*.
——— *Baird*, Brit. Entomost, p. 198.
Cyclops Geoffroyi, *Lamouelle*, British Insects, 81.
Cyclops vulgaris, *Desmarest*, *M. Edwards*, *Leach*.
——— *Baird*, Trans. Berw. Club, i., 97, (young).
——— *Garner*, Nat. Hist., Staffordshire.
Pediculus aquaticus, *Baker*, Empl. for Micros., 383.
Satyr. *Baker*.
Nauplius saltatorius, *Muller*, Zool. Prod., No. 2378.
Four-horned Cyclops, *Prichard*, Microscop. Cab.
Cyclops quadricornis of most recent writers.

The full grown female is often of considerable size, attaining the length of .09 in. or more. The male is smaller, and there is every possible gradation between the above and small forms scarcely perceptible to the unassisted eye.

The cephalothorax is usually regularly oval, but varies from shor oblong, it is composed of four segments, of which the anterior one

equaling or exceeding the remaining three. The superior antennæ vary in length and form. Their shape is that of a letter s. In the male both antennæ possess the hinge, or geniculating joint, which serves as a hand for retaining the female during copulation. The antennæ are about twenty-six jointed, and furnished with numerous setæ. The secondary antennæ are four-jointed, and have six setæ at the end, serving as organs of prehension.

The mandibles are ovoid bodies, terminating in short teeth, and carrying a sort of palpus of two filaments.

The maxillipeds are somewhat similar but are furnished with two toothed processes.

The first pair of feet are organs of prehension, having two rami, of which the smaller, a three-jointed organ, springs from the base of the outer or main branch.

The basal joint of the outer ramus besides bearing the other has two projections on the inner side, the second joint is hook-shaped, as is the final and smallest segment which springs from it. The four following pairs of feet are composed of two rami, each consisting of three setæ-bearing joints, as see plate of Cyclops. There is also a pair of appendages at the base of the first segment of the abdomen. The abdomen is six-jointed, the final joint somewhat bifid, each side terminating in a caudal stylet between which is located the anus.

These stylets give rise to two small setæ on the outer margin and four at the extremity. The inner pair of filaments are usually much the longest, and are also different from the others in having a joint near the base which gives greater freedom to their motions. The setæ are usually barbed backward, and in old individuals are most beautifully pectinate. In cases where the moulting has been arrested these and the other hairs attain a curiously long growth, as illustrated in the plate, and the barblets become filiform appendages.

The digestive canal begins near the front of the thorax and can be traced to the anus. The ovaries are two, and are easily seen in the body, and communicate with external ova sacs. After the eggs are extruded from the ovary into the pouches they are not dependent on the mother, but will come to maturity if separated from her. These eggs vary in number, old individuals laying upwards of forty. It is calculated that in one year a single female would have become the projenitor of 4,442,189,120 young so that the abundance in which they occur, notwithstanding the ravages of the Hydræ, and other enemies, is not strange. A single copulation fertilizes the female for life, as in the case of the Aphides. The eggs, as they are hatched, descend from the ovary covered by a transparent pellicle in which they remain from two to ten days. The growth of the young is illustrated in the plate, the operation occupying about twenty or thirty days. The cyclops moults a number to times during its life, and has the power of replacing lost parts, they are also very tenacious of life, often reviving after being frozen for a long time in the mud and water, which form their hiding places.

The cyclops is probably both carniverous and a vegetable feeder.

Plate III. represents the usual form, the figures showing the different stages are copied from Dr. Baird's Entomostraca. *Plate IV.* gives one of the varieties collected here which may be worthy of a specific name; the greatly exaggerated caudal filaments and general hairiness is, however, only an age-modification, the color of this variety is dark, while the eggs in the sacs are pellucid. Another variety is oblong in shape and lighter in color, while the egg sacs are opaque. Still other varieties are smaller, and vary from bright red to green in color, having the egg sacs diverging from the abdomen. There seem to be intermediate forms and it is best to await further study before separating these varieties. (See Plates III. and IV.)

SUB-FAMILY 2. HARPACTICINÆ.

Characters.—External ovary only one.

* Cephalothorax 4-jointed.

Genus 1. Canthocamptus, *Westwood.*
Genus 2. Harpacticus, *Edwards.*
Genus 3. Westwoodia, *Dana.*
Genus 4. Alteutha, *Baird.*
Genus 5. Metis, *Philippi.*
Genus 6. Clytemnestra, *Dana.*
Genus 7. Setella, *Dana.*

** Cephalothorax 5-jointed.

Genus 8. Laophon, *Philippi.*
Genus 9. Oncæa, *Philippi.*
Genus 10. *Ænippe, Philippi.*
Genus 11. Idya, *Philippi.*

Genus 1. **Canthocamptus.**

Bibliography.—Monoculus, *Linnæus, Fabricius, Jurine,* etc.
Cyclops, *Muller, Ramdohr, Latreille,* etc.
Cyclopsina (part), *M. Edwards.*
Canthocamptus, *Westwood,* Partington's Cyclop. Nat. Hist. art. Cyclops; Entomologist's text-book, 115.
Canthocarpus, *Baird,* Trans. Berw. Nat. Club.
Harpacticus (part) *Dana,* Proc. Amer. Acad. Arts and Sci., 1847.
Nauphilius, *Philippi,* Ann. Mag. Nat. Hist., 1840; Wiegm. Archer, 1843.

Characters.—Body scarcely flattened, generally linear or narrow. Feet of the first pair (second jaw feet of Baird) more often small; those of the second pair with two rami, rami three jointed. Antennæ of the female with an appendage at the end of the fourth joint, those of the male both with a geniculating joint. Appendix to base of the abdomen small. Generally no sudden transition from the segments of the thorax to those of the abdomen.

Canthocamptus minutus. *Bd.*

Bibliography.—Cyclops minutus, *Muller,* Zool. Dan. Prod., No. 2409, 1776; Entomostraca, 101, t. 17, f. 1–7.
——— *Ramdohr,* Beyt, zur Naturg., 10–13, t. 3, f. 1–9.
——— *Latreille,* Hist. Nat. Crust., IV. 266.
——— *Bosv,* Mém. Hist. Nat. Crust., ii. 257.
——— *Lamarck,* Hist. Aus. Vert., V. 189.
——— *Baird,* Trans. Berw: Nat. Club, i. 97, 62, f. 1,19,20, etc.
Monoculus. *Gmelin,* Linn. Sgot. Nat. Edit. 13th, i. 2997, No. 11.
——— *Fabricius,* Ent. Syst., ii. 499, No. 45.
——— *Manuel,* Encyc. mith., vii., 719, t. 267.
Monoculus staphylinus, *Jurine,* Hist. Nat. Monoc., 74–84.
Cyclops —— *Desmarest,* Cons. Gen. Crust. 363, t. 53.
——— *Baird,* Trans. Berw. Nat. Club, i. 97.

Small Cyclops or Vaulter, *Prichard*, Mec. Cab., t. 9, f. 7.
Amyone satyra and Baecha, *Muller*, Entomost., 42 t. 2 (young).
Der Satyr, *Kohlers*.
——— *Prichard*.
Cyclopsina staphylinus, *M. Edwards*, Hist. Nat. Crust., iii. 428.
Canthocarpus ——— *Baird*, Trans Bew. Club, ii., 154.
Nauphilius minutus, *Philippi*, Weigm. and Erichs, Ar. 1843, 69.
Doris minuta, *Koch*, Deutsch, Crust., li. XXXV. t. 3, 1841.

Variety occidentalis. Herrick.*

Description, etc.—This variety, which is the only member of the sub-family yet distinguished in our locality, is so closely related to the type of the species as described by Dr. Baird that it is with much hesitation that it was finally concluded to separate it. The description given will apply to both, with such exceptions as will be pointed out.

Body rather long with no obvious distinction between the segments of thorax and abdomen, composed of ten segments, which taper toward the tail. Cephalothorax acute in front, resembling that of species of *Calanus* (in which respect it differs from Dr. Baird's figures of the European species) forming a sort of beak below. Viewed from the side the shape is triangular. The primary antennæ are shorter than in Cyclops, and those of the males more altered than is usually the case in that genus. In the male they consist of seven joints, the fourth of which is much enlarged.

The antennæ of the female possess eight or nine joints. and have a small projecting appendage from the extremity of the fourth segment. The secondary antennæ are simple with two or three joints.

The eye is bright red and contrasts finely with the pale yellow of the body. The mandibles are similar to those of the cyclops. The maxillipeds are divided at the end into four divisions at the extremity of which spring three or four setæ.

The first pair of feet (or second foot-jaws of Baird) are small, three-jointed organs. The final joint is hook-like, and directed forward for the purpose of arresting food particles and carrying them to the mouth.

The second pair of feet are large and modified in form, differing from the natatorial feet, (they form the basis of classification in this whole sub-family). Each is composed of two three-jointed rami, of which the outer one has the joints nearly equal with three setæ. At the apex of the final one, the inner ramus has the upper joint long, almost equalling the outer ramus. The second joint is shorter and with the final one, which carries at the extremity three long setæ, is serrated on the anterior margin. This ramus is directed forward also. The three following pairs have the rami unequal but both with three joints.

The sexual openings are at the base of the sixth segment. In copulation the males seize the caudal stylets with the geniculating joint of the primary antennæ and are bourn about rapidly by the female.

In most of the females seen there was a organ attached to the vulva, it consists of a long flexible stalk terminated by a cylindrical or club-shaped mass, which may be dark brown, red or pellucid.

*S. A. Forbes describes a species in Report Ill. Mus. Nat. Hist., the characters of which I have not been able to compare with our specimens, but it seems distinct.

It was conjectured by M. Siebold that these were similar to the seminal tubes discovered by him upon Diaptomus. The act of copulation in Diaptomus, as described by him, is so strange and improbable that it is hard to accept without some hesitation. He says that "the male does not accomplish a true coition but attaches to the female, during copulation, a tube containing spermatic liquor. This tube contains, beside the zoosperms, two substances of which one swells by the influence of water, and chases out the whole contents of the tube. The other substance coagulates, leaving in the middle of the mass a canal by which the zoosperms arrive at the vulva."

In the case of the Canthrocamptus, however, the appendage is apparently of a different nature, being corneous and harder than the rest of the animal, moreover in no case have more than one of these been observed on the same female. Jurine, however, says that this body is never seen till after she has several times laid eggs. Dr. Baird adds that he has never seen more than one on the same female, and that no mature female is met without it, even though the ova are attached. My own observations accord with the above, but I am unable to add any suggestion as to the use of these organs.

The females are larger and usually darker in color than the male.

Habitat.—Shallow lakes and pools; everywhere abundant.

This species will repay well patient study, and from its abundance is easily found. This western variety is distinguished from the eastern type by the shape of the head, the greater brevity of the caudal stylets. the shape of the ova sac, the greater size of the fourth joint of the male antennæ. and other minor differences, which no great stress is laid upon, however; and these variations may be due to inaccuracies of the drawings of Baird's book. (See plate V.)

Sub-family 3. *Steropinæ*, Dana.

Characters.—Form somewhat like Sapphirina, but the eyes minute, and generally situated in a prominence in the front. Superior antennæ short. Feet of the first pair monodactyl as in Corycæcidæ. Caudal stylets short, sub-cylindrical.

Genus 1. Zaus, *Goodsir.*

Genus 2. Sterope, *Goodsir.*

No member of the family was met with.

FAMILY III. CORYCÆIDÆ.

The species are all oceanic. A species of Sapphirina is figured in the Rep. of Fish and Fisheries for 1871 and 1872.

TRIBE II. DAPHNIOIDEA. Dana.

Bibliography.—Daphnioidea, *Dana*, Rep. Wilkes' Expl. Ex., p. 1262.
Cladocera, *Baird*, Brit. Entomost. p. 62, 1850.
——— *Burmeister*, But. zur Naberg. Der Rankenfuss.
Daphnides, *Straus*. Mem. Mus. d'Hist. Nat.
Daphnoides on Cladocères, *M. Edwards*, Hist. Nat. Crust., iii. [illegible]
——— *Lucas*, Exp. Sc. de l'Algine.

Characters.—This tribe which corresponds with the *order Cladocera* and some recent authors, is characterised as having

body, exclusive of the head, (which is covered with a separate and similar plate) included in a large carapace, which is open below and behind, permitting the protrusion of the posterior portion of the abdomen, and allowing currents of water to pass within, both for respiratory purposes and to carry to the mouth particles of food.

The carapace is composed of three parts, in one species at least, and it would seem that this is the typical structure. The middle plate (in Daphnia vetula) lies over the dorsal region; the other two spring from it, flanking it on either side, and forming the bulk of the shield. We would suggest the probable similarity of the central shield to the caudal shield of other crustaceans, and the possibility that the now larger portions ought really to be considered as accessory simply.

The Daphinoidea possess from four to six pairs of foliaceous appendages, or branchial feet which do not assist in locomotion. The eye is apparently single and is a very prominent organ in all the members of the tribe, it is large and furnished with numerous lenses.

The superior antennæ are small, often obsolete, and except in Bosmina only one or two-jointed. The inferior antennæ are large, being the true organs of locomotion, and several-jointed.

The abdomen is incurved, mobile, furcate at the extremity and bears two prominences on the dorsal angle which are the origin of setæ.

The carapace is often beautifully reticulated and sometimes there are more than one sort or series of these markings. The Daphinoide are distinguished from Cyproidea by the presence of posterior foliaceous legs, which is considered by Dana as of greater importance than the more obvious peculiarity—the exclusion of the head from the carpace.

Prof. Dana has united the genera of Dr. Baird's *Daphniadæ*, *Polyphemidæ* and *Lynceidæ* in this tribe, and this seems appropriate, since there cannot certainly be as wide a gap between *Daphnia* and *Lynceus* as between the curious *Bosmina* and *Daphnia*, yet the latter two were united in one family and Lyncens separated as totally distinct. The chief peculiarities which lead to the separation of Lynceidæ were first, the fact that they possessed in front of the eye a "black spot" of unknown use, and second, that the head was produced in front to form a more or less prominent beak.

But it has since been ascertained that the black spot is a common feature among the species of the whole tribe and, according to modern authors, is in someway connected with the base of the superior antennæ and serves, probably, as an organ of hearing.

The characters of the head seem to have been misunderstood. In all the species of the Daphinoidea which I have examined, the head seems to be covered with a curved plate or carapace, within which is the insertion of the organs of the head. Now a little change of position under the microscope serves to give to the anterior portion of this covering on acute or obtuse appearance, depending on which side of the carapace is in the focus of the instrument. As the shape of the beak is used as a generic character in this sub-division it seems quite probable that the matter will need further revision. The fact that the intestine is or is not convoluted was shown by Dana to be of no generic importance.

The characteristics of the tribe may be best seen as illustrated in the subdivisions.

FAMILY 1. PENILIDÆ. Dana.

Bibliography.—Penilidæ, *Dana*. Pro. Amer. Acad. Sci., ii., 47, 1849.
Sidina, *Baird*, Brit. Entomost, 106.
Sididæ, *Gray*, Cat. Brit. Crust. Brit. Mus., 93, 1850.

Characters.—Foliaceous feet twelve, narrow. Anterior antennæ obsolescent.

Genus 1. Sida, *Straus*. Posterior antennæ with the longer ramus three-articulate, shorter, two-articulate. Head not beaked below.

Genus 2. Daphnella, *Baird*. Both rami of posterior antennæ two-jointed. Anterior antennæ borne by the middle of the under aspect of the head.

Genus 3. Penilia, *Dana*. Both rami of the posterior antennæ two-jointed. Head short, produced below. Primary antennæ borne on the extremity. Species marine.

? Genus 4. Latona, *Strauss*. Posterior antennæ having three one-articulate rami.

Only one species of this family has been met with, which is here described.

Genus 1.

Sida, *(Straus.)*

Bibliography.—Sida, *Straus*, Minn. Mus. Hist. Nat., v.
—— *M. Edwards.*
—— *Baird.*
—— *Dana.*
Daphnia, *Mulller.*
———— Latreille, etc.
Monoculus, *De Geer.*
————— *Jurine, etc.*

Generic Characters.—Superior antennæ of moderate size. Longer rami of inferior antennæ with three articulations, shorter rami with two. Inferior antennæ very large and powerful.

Sida crystallina, *Muller.*

Bibliography.—Daphne crystallina, *Muller*, Zool. Dan. Prod., No. 2,405, 1,776.
Daphnia crystallina, *Muller*, Entomost., 96, t. 14, f. 1–4.
———— ———— *Latreille*, Hist. Nat. Crust. IV., 230.
———— ———— *Bosc*, Minn. d'Hist. Nat. Crust. II., 281.
Sida crystallina, *Straus*, Minn. Mus. Hist. Nat., V.
Sida crystallina, *M. Edwards*, Hist. Nat. Crust., III., 383.
Monoculus crystallina, *Gmelin*, Linn. Lyst. Nat., edit. 13th, I. 3,000, No. 29.
———— ———— *Manuel*, Enc. Mith., VII. 724, t. 265, f. 15–18.
———— ———— *Fabricius*, Ent. Syst., II. 493.
Monoculus elongatus, *De Geer*, Mem. Servis Hist. Ins., VII. 470, t. 29, f. 1–4, 1,778.

Description, etc.—General shape that of an elongate rectangular prism, or sub-cylindrical. Carapace elongate oval, truncate before and behind, very transparent, being obviously reticulated only near the anterior portion.

Head large, obtuse in both vertical and horizontal aspect, furnished with a projecting disc or plate on the posterior part of upper surface. Eye round and rather large, red, with many corneæ.

Superior antennæ are quite observable, being rather long and armed with four bristles on the extremity.

Inferior antennæ very large. The basal joint is cylindrical, very large and fleshy, and wrinkled so as to appear many jointed. The two rami are unequal and rather short. The outer ramus has three articulations. The first is short and furnished with a minute spine. The second is longer and has three strong-jointed setæ on the inner margin, and a spine near its articulation with the third, which is of nearly the same length, and has four setæ on the inner margin, three at the end and a small spine at the upper outer angle.

The inner ramus has two unequal joints, the lower of which is much the longer, and is furnished with a spine and a seta, while the second has four large-jointed setæ at the extremity.

The labrum and mandible are similar to those of Daphnia.

The feet are of six pairs, which are described as follows:

The first pair consists of a main stalk of two joints, of which the first has four setæ, and the terminal (or "hand") joint seven. The first joint also has two branchial plates, of which the upper and smaller possesses nine or ten short setæ and one jointed and plumose filament, while the lower or main plate has about thirty plumose setæ. The second, third, fourth and fifth pairs are quite similar, but the stout setæ on the outer margin of the first joint are replaced by a triangular plate and the branchial filaments are shorter. The sixth pair has three articulations, each furnished with straight, stout spines, and is curved. The abdomen has at its extremity two strong, curved claws, which have each three spines on the basal half, and are dentate for the remainder of their length; it also has two tubercles at the angle behind each of which bears a long seta. Between the claws and these knobs are two rows of spines.

The ovary contains in full grown females, about twenty young, which resemble their parent from birth.

The organ on the top of the head is used as a sort of sucker, by which the animal adheres to water plants.

Their motion is rapid and steady. The circulation of the blood can be seen through the transparent walls of the body and head, as in the front part of the head, where the minute, colorless corpuscles are easily seen coursing from above. There appears to be a dorsal vessel just above the intestine in which these globules can be seen as they pass from behind forwards to near the juncture of the carapace with the glabella of the head, where is an enlargement forming the heart, the pulsations of which are uniform with the motions of the branchial feet. The motion of the feet, besides the aeration of the blood, propels (as in others of this family) a strong current of water between the bases of the limbs toward the mouth, bringing to it the particles on which it feeds and which it has no other means of capturing.

This interesting creature is quite rarely seen, whether from its reclusive habits or actual scarcity I do not know, but it deserves the attention of students, as presenting, both on account of its size and transparency and its somewhat anomalous structure, one of the best opportunities of investigating these little known forms.

Habitat.—"Grassy Lake," a pond tributary during high water to Lake Calhoun, near Minneapolis; also Diamond Lake. The animal seems to be found in lakes not completely isolated, and does not prefer so muddy a situation as most of the Daphnioidea.

The structure of this animal was compared minutely with the description given by Dr. Baird of *S. Crystallina*, and is beyond doubt identical. *Plates VI and VII.*

FAMILY II. DAPHNIDÆ.

Bibliography.—Daphnidæ, *Dana*, Rep. Wilkes' Expl. Exp., p. 1265.
——— *Dana*, Proc. Amer. Acad. Sci., ii., 1849.
Daphnita, *Gray*, Cat. Brit. Crust. Brit. Mus., 88.
Daphniadæ, (part), *Baird*, Brit. Entomos. 62.

Characters.—Foliaceous feet ten. Anterior antennæ one or two-jointed.

1. Head large.

Genus 1. Daphnia, *Muller*, (including Ceriodaphnia of Dana, which differ in the shape of the reticulations of the shell.)
Genus 2. Moina, *Baird.*
Genus 3. Macrothrix, *Baird* (including Acanthocerus of Schodler.)

2. Head short.

Genus 4. Lynceus, *Muller* (including *Eurycercus*, *Chydorus*, *Peracantha*, *Pleuroxis*, *Acroperus*, *Campotercus* and *Alona* of different authors, until some valid generic characters are announced.)

Genus Daphnia, Muller.

Bibliography.—Daphnia, *Muller*, Zool. Dan. Prod.
——— *Muller*, Entomost.
——— *Straus*, *Desmarest*, *Latreille*, etc.
Monoculus, *Linnæus*, *Poda*, *Blumenbach*, *De Geer*, etc.

The Daphniæ are among our most abundant and most interesting Entomostraca, occurring in stagnant water everywhere, they are very prolific and voracious. This genus is confined strictly to fresh water.

The general characters will be gathered from the description of the tribe and of the species. The superior antennæ are usually rudimentary and hidden, but vary with the sexes. The most prominent organs are the inferior antennæ, which are large and powerful. They consist at the base of a single large, fleshy joint which has all possible play upon its attachments. This joint supports two branches of nearly equal length, but the outer is usually four-jointed, while the inner has but three articulations. Each of the last three is furnished with a long seta which is jointed at the middle, and usually pecinate, forming a fine swimming organ. The eye is a large, conspicuous organ near the front and is so furnished with muscles that it has a semi-rotation. This organ occupies a prominence on the underside of the head, which projects backward supporting the minute antennæ and the black spot before noticed. Baird says that the eye was mistaken by one author for the *stomach*. The chief gangilon of the nervous system lies near and communicates with the eye. The mouth lies at the back of the prominence described, and is armed with a labrum, a pair of mandibles and a pair of jaws. For particulars of structure see plate IX.

The digestive system is the most conspicuous part of the creature when filled. It is then often of a brillant green color, extending along the whole dorsal region. The œsophagus is short, opening into the stomach just behind the brain ganglion. From this point the stomach curves upward and extends thence through the whole length of the animal. The contractile vessicle above the stomach is quite an obvious feature, but Gruithuisen says there are two hearts, one venous, the other arterial, but this is probably not established, though the existence of a dorsal vessel above the stomach is probable from analogy and observed appearances.

The legs, which are of five pairs, vary considerably, but the same plan is preserved. At the base of each is a branchial plate furnished with fine branchial filaments corresponding to gills, while the remaining portions of the leg serve to create currents of water toward the mouth. The result is a vigorous current between the legs under the body, which transports the food particles to the maxillæ. The ovaries are along the sides of the abdomen, and the ova are normally hatched within the shell of the parent above the abdomen.

These creatures have been supposed hermaphroditic, from the extreme scarcity of the males, but they are in this respect like the Aphides, being parthenogenetic. Besides the ova which are hatched within the shell of the living parent, another method is seen. The outside of the carapace grows opaque, and finally two spots appear within which are the eggs. When the moult takes place, the carapace with its burden is left in the water until a favorable time, when the eggs hatch. This obviously is a protection against the cold of winter, for the ephippium, as the carapace thus loaded is called, is thick and horny. The ephippia may be observed in winter, floating about in the water, often in abundance. (See plate IX.)

Daphnia Pulex.

Bibliography.—Monoculus pulex, *Linnæus*, Sys. Nat. 10 Ed., i., 635, No. 4, 1758.
——— *Gmelin*, Syst. Nat. 13th Edit., i., 2999, No. 4.
——— *Poda*, Ins. Mus. Græcus, 124.
——— *Muller*, Faun. Insect. Fredrichsdalens, 95.
——— *Blumenbach*, Handbuch der Naturg., 399.
——— *Manuel*, Enc. nieth., VII., 722, No. 15, t. 265, f. 1-4.
——— *Fabricius*, Entoml. Syst., ii., 497.
——— *Leach*, Encyc. Brit. art. Entoml.
——— *Jurine*, Hist. des Monoc., 85.
——— *Cuvier*, Tab. Element., 455.
Daphene pulex, *Muller*, Zool. Dan. Prod., 199, No. 2400, 1776.
Daphnia pulex, *Latreille*, Gen. Crust. et Ins.; Hist. Nat. gen. et part., des Crust; Règne Anim. Cuv.
——— *Lamarck*, Hist. Nat. des An. s. Vert. Edit. 2, V., 181, No. 1.
——— *Lamouelle*, British Insects, 81.
——— *Straus*, Mem. der Mus. d'Hist. Nat., v. t. 29.
——— *Demarest*, Consid. gén. sur les Crust., 372, t. 54.
——— *Baird*, Ann. Nat. Hist., i., 254.
——— *M. Edwards*, Hist. Nat. des Crust.
——— *Guerin*, Iconograph. Crust., t. 33.
Daphnia pulex, *O. Fabricius* Faun. Grœnland., 263.
——— *Leach* Edin. Encyc., vii. art. Crustaceol.

Daphnia pennata, *Muller*, Entomost., t. 12, f. 4–7.
——— *Bosc*, Man. d'Hist. Nat. des Crust., ii., 280.
——— *Schrank*, Faun. Boic., iii., 264.
Monoculus pulex arborescens, *Linn*. Syst. Nat.. 4th Edit., 96.
Pulex arborescens, *Swammerdam*, Hist. Nat. Ins. Gen., 76, t.
f. o. b. c. Biblia Naturæ, 86, t. 31, f. 1–3.
——— *Goeze* Naturfoscher, pt. 7.
Monoculus pulex ramosus, *De Geer*, Mém. pour servir à l'Hi
Ins., vii., 442.
Daphnia ramosa, *Koch*, Deutsch. Crust., h. XXXV., t. 18.
Daphnia media, *Koch*, Deutsch. Crust., h, XXXVII. t. 1.
Daphnia ephippiata, *Koch*, Deutsch. Crust., h. XXXV t. 16.
Puckron branchu, *Trembley*.
Water-flea with branching horns, *Baker*, Empl. for Micros.
Pou aquatique, *Joblot*, Observ. d'Hist. Nat.
Le Perroquet d'can, *Geoffroy*, Hist. abrég. Ins.
Vermes minimi rubri, *Merrett*, Pmax Res. Nat. Brit.
Ammaletti aquatici, *Redi*, Asservazioni. Opere.
Monoculus, *Bradley*, Phil. Occ. of Works of Nature.
Le Puceron verdatre, *Ledermuller*.

Var. 1. Daphnia longispina, *Muller*.
——— *Latreille*.
——— *Bosc*.
——— *Ramdohr*.
——— *Lamarck*.
——— *Straus*.
——— *Demarest*.
——— *M. Edwards*.
——— *Koch*.
Monoculus longispinus, *Fabricius*.
——— *Manuel*.
——— *De Geer*.
——— *Schæffer*.

Var. 2. Daphnia magna, *Straus*.
——— *Demarest*.
——— *M. Edwards*.

Description.—Carapax oval or sub-quadrangular, transparent, more or le reticulated on all or part of the surface. Head large, more or less beaked. S perior antennæ very small. Inferior antennæ strong and long. The superi antennæ have five small setæ at the apex, while the inferior pair are armed wi the usual complement of setæ, which in this species ar

The color of this animal, which is our commonest an cies, is dependent upon the food taken into the stomac nearly the whole length of the body in all the speci clean vegetation the intestinal canal is of a brilliant g times it is dark or brownish. In England they are c throughout, but I have never met with such here.

The carapax is terminated posteriorly by a serrated situated, and varies also with the age of the animal. situated at the upper posterior angle while in others it the posterior aspect. In the young the spine is long, a

the carapax in length, but at each successive moulting the spine is found to be shorter. The upper part of the body has four projections, one of which is longer than the others and serves evidently to keep the ova in position.

Dr. Baird says that "the male is much smaller than the female", which is the case in nearly all the species, "and the superior antennæ are much larger and spring from under the beak instead of from the beak itself. The inferior extremities of the valves are more densely serrated than in the female."

The males are always fewer than the females. The motions of this creature are quick, spasmodic leaps through the water, and it often presents a beautiful appearance.

Daphnia Vetula.

Bibliography.—Daphne vetula, *Muller*, Zool. Dan. Prod., No. 2399.
Daphnia vetulo, *Straus*, Mém Mus. Hist. Nat., V., t. 29, f. 25–6.
——— *Baird*, Ann. Mag. Nat. Hist., i., 255, t. 9, f. 13.
Daphnia sima, *Muller*, Entomost., 91, t. 12, f. 11–12, 1785.
——— *Latreille.*
——— *Bosc.*
——— *Ramdohr.*
——— *Gruithuisen.*
——— *Desmarest.*
——— *Lamarck.*
——— *M. Edwards.*
——— *Koch.*
Monoculus sima, *Givelus.*
——— *Manuel.*
——— *Jurine.*
Monoculus lævis, *Fabricius.*
Monoculus expinosus, *De Geer.*
Monoculus conchacus, *Donovaan.*
Ungeschwauzter-zackiger, *Wasserfloh, Schœffer.*
Monoculus nasutus (?) *Jurine.*
Monoculus pulex, *Sulger.*
Daphnia congener, *Koch.*
Daphnia expinosa, *Koch.*

Description.—In size like *Daphnia pulex*, some forms of which it resembles. Carapax in the male quadrangular with the sides nearly parallel, the posterior prominence being near the dorsal part of the shell. In the female, however, the prominence is near the middle of the posterior side, while the carapax is widest near that extremity. The spine usually present in the larger Daphnidæ is obsolete, but there is a series of small spines or teeth on the upper posterior margin. The lower edge is strongly ciliated. The carapax is strongly lined transversely. These striæ arise from the one or two rows of hexagonal cells which border the lower margin, and anastomose occasionally, giving in some cases a reticulated appearance to the shell. The head is very small proportionately, rounded in in front, and rather strongly beaked below.

The superior antennæ are quite evident. Inferior antennæ large. The first joint is fleshy and stout, margined at the extremity with spines and sending out three branches, of which the two large swimming organs are as in *pulex*, having the plumose setæ, etc. At the base and between these is a third, consisting of a conical point with a broadened base ending in a spinous appendage. The scuta

of the head seems wider and less arched than in other species. Jaws long a[...] ending in a circle of fine teeth. Feet as in *pulex*.

Seen from above the carapax of the body is found to consist of three piec[...] The first, which might be termed the scutella, is a small shield adjoining t[...] head, and the two principal pieces or valves of the shell may be considered [...] appendages of the scutella. These pieces may be compared to the *tergum* a[...] *pleuron* of trilobites.

The structure of the beak and its relation to the head is more clearly seen th[...] in most of the Daphniæ. The head shield as seen from below is transverse[...] sub-oval. Directly in front and very near the anterior margin of the skull is [...] eye, filling a circular elevation reaching the anterior margin, and sending [...] posteriorly a ridge or straight partition which divides the lower aspect of th[...] head into two basin-like cavities. This ridge terminates in the beak which ca[...]ries the superior antennæ and the black spot which Huxley calls an ocular pig[...]ment, but by other authors is thought to be attached to the auditory apparatu[...] and is termed by Dana the "otolites", following Schoder in so consideriug i[...] (See *Plates X. and XI.*)

Daphnia Mucronata.

Bibliography.—Daphne mucronata, *Muller*, Zool. Dan. Prod., No. 2404, 1776.

Dapnia mucronata, *Muller*, Entomst., 94.

———— *Desmarest*. Cons. gèn. Crust. 374.

———— *Latreille*, Hist. Nat. Crust., IV., 229.

———— *Bosc*, Man. d'Hist. Nat. Crust., ii., 281.

———— *M. Edwards*, Hist. Nat. Crust. iii., 382.

———— *Baird*, Trans. Berw. Nat. club, ii, 148.

———— Monoculus mucronatus, *Gmelin*, Linn. Syst. Nat.[...] edit. 14th, i., 3,000, No. 28.

———— *Manuel*, Enc. Mith., t. 265, f. 19.

———— *Jurine*, Hist. Nat. Monoc. 137, t. 14, f. 1, 2.

Monoculus bispinosus, *De Geer*, Mem. Servir. Hist. Ins., VII.[...] 463, 1778.

———— *Fabricius*, Ent. Syst., iii., 493.

Daphnia bispinosa, *Koch*, Deutsch. Crust., h. VIII., t. 1.

Description.—General shape, as seen from above, oval. Lower margin of th[...] carapax straight, terminated posteriorly by a curved spine. Head triangular[...] obtuse in front. Eye large. Superior antennæ small. Inferior antennæ long[...] Lower part of the carapax ciliated. Color dark. Dr. Baird says that th[...] form of the head varies in this species, being sometimes rounded and at other[...] terminated by a sharp, somewhat curved point directed upwards.

I have not observed in any of the many specimens seen a sharply pointed head[...] and though this point casts some doubt on the identification, every other poin[...] in his description seems to agree very well with our species, which I find no war[...]rant for separating from *D. mucronata* var. *obtuse rostrata*.

Habitat.—Sandy Lake (East Minneapolis), Clark's Lake, Grassy Lake, etc[...] (See *Plnte XII.*)

Daphnia (Ceriodaphnia, Dana) Reticulata.

Bibliography.—Monoculus reticulatus, *Jurine*, Hist. Nat. Monoc., 139, t. 1[...]

Daphnia reticulata, *Desmarest*, Cons. gén Crust., 374.
M. Edwards, Hist. Nat. Crust., iii., 381.
——— *Baird*, Trans. Berws. Nat. Club. ii., 148.
Daphnia ventricosa (?) *Koch*, Deutsch. Crust., h. XXXV., t. 21.
Daphnia quadrangula, *Muller*, Ent., 90, t. 13. f. 4.
——— *Latreille*, Nat. Hist. Const. IV., 227.
Monoculus quadrangula, *Gmelin*, Linn. Syst. Nat., 2999, No. 24.
Monoculus quadrangularis, *Manuel*, Enc. Mith., VII., 723, No.15.
Monoculus quadrangulus, *Fabricius*, Ent. Syst., ii., 492.

Note.—I was not able to fully satisfy myself that this is certainly identical with the species described by Baird but there are no good reasons for believing it a distinct species. It is round enough for D. *rotunda*. There is an evident spine on the posterior angle of the shell, though it sometimes is almost obsolete.

The reticulations are hexagonal (?). The color in the specimens examined is greenish, and moreover the superior antennæ agree better with *reticulata* than *rotunda*. The size is small.

Description.—Small (.02 in. or over). Carapace oval and comparatively very broad, covered with hexagonal markings. Head small as compared with the body, and more nearly at right angles with it than in most of the Daphniæ. There is also a slight depression a little in front of the juncture with the body. Superior antenæ rather larger than in most Daphniæ, and somewhat movable. Inferior antennæ quite large. Beak none. Feet as in the larger species.

This species is very active on account of the length of the antennæ, which have shorter spines (not plumose) than *D. pulex*. It presents a robust appearance in swimming either on its back or face, since it is much broader in proportion than most other species.

Habitat.—Lake Amelia, Grassy Lake, etc. Not very abundant but widely distributed.

Baird says of this species: "The ephippium differs considerably from that of *pulex*. It is more rounded, white at the centre, with a large round ampulla, containing only one ovum. When the animal has the ephippium on, it possesses a square appearance, and is the *D. qaadrangula* of Muller."

This is one of the commonest species in many of our lakes, while in others it is replaced by the *pulex*, for as yet I have not seen them both in the same locality.

Habitat.—Grassy Lake, Lake Amelia, etc.

(See Plate VII.)

Daphnia spinosa, Herrick.

Description.—General shape of the Daphnia pulex; carapace armed at the upper posterior margin with a rather long, serrated spine. The first of feet are long, bristled at the extremity as in young specimens of D. pulex. The anterior antennæ are larger than in pulex and two-jointed and setæ-bearing at the end. Posterior antennæ exactly as in pulex. The eye is nearer the antennæ than in other species, but the most striking peculiarity is the pointed spine formed by the front of the head, which is very marked. Carapace not obviously reticulated, transparent.

Habitat.—Found in Lake Calhoun, but not in large numbers. It seems to inhabit the deeper waters.

(See Plate XIII., p. 1.)

GENUS **Macrothrix.**

(Sig.—long hair.)

Bibliography.—Macrothrix, *Baird*, Ann. Mag. Nat. Hist., XI, 87, 1843, and XVII, 412; Trans. Berw. Nat. Hist. club, ii, 149.
Daphnia, *M. Edwards*, Hist. Nat. Crust., iii, 384.
———— *Muller* (?) Entomost.
Lynceus, *Desmarest*, Cons. Gen. Et. Part. Crust., 376.
Monoculus, *Jurnine*, Hist. Monoc. Generc.
Acanthocercas, *Schulder* Ericks, 1846.
Macrothrix, *Dana*, Wilkes' Explos. Exp. Report.

Characters.—Head, beneath, either subacute or rather obtuse, anterior antennæ rather long, pendulous from the beak, eye accompanied by a rather large black spot at the base of the attennæ; seta from first joint of anterior branch of inferior antennæ much longer than the others.

Macrothrix agilis, Herrick.

Description.—Head shield (as seen from above) very nearly square; body carapace pear shaped; eye smaller than in *Daphnia* and accompanied with a rather large black spot similar to the obvious spot in Lynceus, but even larger. Superior antennæ very long in comparison with other members of the family. Inferior antennæ rather large, armed with large setæ, of which the spine from the end of the first joint is extremely elongate and plumose, nearly as long as the body. This joint also has a small spine on the opposite or upper side of the ramus.

The spine from the second joint is larger than in *Daphnia*. The final joint bears a small spine also in addition to the three setæ. (In the drawing both of the rami have the elongate seta. This may be a mistake in the observation, which was made in some haste.)

The jaws, feet, and posterior segments of the body, are similar, as far as observed, to like organs in *Daphnia*.

The lower and posterior part of the margin of the carapace bears a number of long stout spines directed backward. The posterior body filaments, instead of being simple or only plumose, are divided at the extremity into four small bristles, forming a tassel or brush at the end.

The intestine is not convoluted but is more abruptly curved and depressed near the head than in *Daphnia*, thus approaching *Lynceus*.

The motions of this interesting animal are lively and impetuous, it being assisted by the long filaments of the antennæ, which, with the body spines and strong teeth of the shell, give to it a spider like aspect.

This species differs materially from any described by Baird, or any other author with which I am familiar, but even if the elongate filaments should prove to be common to both rami of the antennæ, it must fall in this genus.

Habitat.—Only observed in Rocky Lake, a small pool near East Minneapolis.

Plate XIV.

GENUS **Lynceus,** Muller.

This genus was rejected by Dr. Baird who founded upon its remains a number of genera, most of which were rejected in turn by Prof. Dana, who recognizes

Lynceus, Eurycercus and *Alona.*
Lynceus—Eurycercus of Dr. Baird.
Eurycercus—Chydorus, Percantha and *Pleuroxus.*
Alona—Alona, Acroperus and *Camptocercus.*

In the genus *Alona*, he says. the beak diverges from the body at a large angle (60° to 90°) with the shell adjoining, while in *Lynceus* it is usually curved parallel to it.

But, as Dana himself admits, the distinctions are of doubtful importance, and it would seem preferable to retain Muller's old genus instituted for all of these forms than to further complicate the matter until a large amount of material shall be gathered and compared. The species observed will, therefore, be briefly described and the probable place in the rejected genera indicated.

Lynceus macrourus. Muller.

Bibliography.—Lynceus macrourus, *Muller*, Dan. Prod., 2397.
——— *Latreille*, Hist. Nat. Crust., 207.
——— *M. Edwards*, Hist. Nat. Crust., iii. 388.
Monoculus macrourus, *Genelin*, Syst. Nat., 3008, No. 65.
Monoculus macrourus, *Manuel*, Enc. Mith., vii, 733, No. 68.
——— *Fabricius*, Ent. Syst., ii, 499.
Camptocercus macrourus, *Baird*, Ann. and Mag. Nat. Hist. ii; Trans. Berw. Nat. Club. ii, 150; British Entomost. p. 128.

Description.—Carapace pear-shaped, transparent, finely lined longitudinally, sinuated on the lower margin, which is ciliated for most of its length. Head rather small, with a short, blunt beak projecting straight downwards. Superior antennæ rather large, situated about half way from the extremity of the beak to the body. Inferior antennæ long, with long setæ at the extremity, eyes small, first pair of feet large, abdomen very long and slender, serrated with well marked teeth on the posterior edge and terminating in the usual pair of claws. The extreme length and narrowness of the abomen formed the basis of the genus *camptocercus* of Dr. Baird, this species being the only one described under it. The intestine is convoluted, and there is an opening near the juncture of the last segment of the abdomen with the rest of the body from which a long vessel begins and extends above the stomach, as at (a) Fig. 1, Plate XV. This species is quite abundant.

Lynceus quadrangularis, Muller.

Bibliography.—Lynceus quadrangularis, *Muller*, Zool. Dan. Prod., No. 2393, 1876.
——— *Latreille*, Hist. Crust., 208.
——— *Baird*, Trans. Berw. Club.
——— *M. Edwards*, Hist. Crust., iii., 388.
——— *Kock*, Deutsch. Crust. L. XXXVI.
Monoculus quadrangulus, *Gmelin, Maduel.*
Monoculus quadrangularis, *Fabricius.*
Monoculus striatus(?) *Jurine.*
Alona quadrangularis, *Baird*, Ann. and Mag. Nat. Hist., ii. 92
Trans. Berw. Club, ii. 151;
Entomostraca, p. 131.

Description.—Carapace ovate quadrangular, but somewhat variable, being in some specimens quite abruptly rounded on the posterior margin, while in others it is almost truncate; shell of a yellowish or brown color, heavily marked and ciliated below. Beak blunt, varying in position in different individuals. Abdomen flat, sinuated at the extremity and bearing long claws. Anterior antennæ of moderate size. Eye rather large. Larger antennæ rather long.

Total length between .03 and .04 in. This species is also quite abundant, and if I am right in referring it to the *L. quadrangularis* of Muller, is quite variable. Drawings made from individuals collected at different localites on comparison show minute differences of form and markings. The intestine is strongly convoluted in this species, but the dark color of the shell usually interferes with observations of the organs within.

Plate XV. fig. 2.

Lynceus sphæricus, Muller. (?)

Bibliography.—Lynceus sphæricus, *Muller.*
————*Latreille.*
————*Lamarck.*
————*Desmarest.*
————*Baird.*
————*M. Edwards.*
————*Prichard.*
————*Koch.*
Monoculus sphæricus, *Gmelin.*
————*Manuel.*
————*Fabricius.*
————*Jurine.*
Monoculus infusorius, *Schrank.*
————*Eichorn.*
Chydorus Mulleri, *Leach.*
Chydorus sphæricus, *Baird*, Ann. and Mag. Nat. Hist. ii. 89, t. 2; Brit. Entomst. p. 126.

Description.—Baird's description of this species is applicable to any one of several almost equally, and the only recourse seems to be a reliance on the figure he gives with which our species seems to correspond quite well.

The shell is round and nearly blunt behind, the antennæ are quite small, so that the animal rolls slowly along like a corpulent sailor on land. Not enough attention has been devoted to this and the following species of the genus. Length, .03 in. Plate XIII, fig. 2.

Lynceus sp.?

See L. (Pleurus) trigonellus, P. uncinatus etc. of Baird.

The animal figured in Plate XII, Fig. 3, evidently belongs to the genus *Pleuroxus* of Baird. In examining several specimens the turned up beak was found in several cases while in others it was seen as represented at (3a) of the same plate. Dr. Baird separated two species on the ground of this variation, but it does not seem to be a specific character. The length is .03 in. in the species seen, and except that the shell is longer in proportion, agrees [illegible] with L. trigonellus, Muller.

Lynoeus sp.?

Another member of the genus differing from any description met with is shown in plate XVI. It is the smallest form seen, not exceeding .02 in. The feet are proportionally large, as is the eye, while the antennæ are quite small.

FAMILY Bosminidæ.

This family has been removed, by Prof. Dana, (justly it would seem to us) from *Dahpnidæ*. The general appearance is unique, and the characteristics of the superior antennæ places the only member in the single genus composing this family at quite a distance from Daphnia and its allies.

Characteristics.—Foliaceous feet, ten in number; anterior antennæ elongate and many-articulate.

GENUS Bosmina.

Bibliography.—Daphnia, *M. Edwards.*
———— *Desmarest.*
———— *Baird.*
Monoculus, *Jurine.*
Lynceus, *Muller.*
———— *Latreille.*
Bosmina, *Baird*, Trans. Berw. Nat. Club, 1845; Ann. Mag. Nat. Hist. VI., 412.

NOTE. (Name)—"Bosmina," a daughter of Fingal.

Generic characters.—Superior antennæ long, curved, cylindrical, consisting of many small articulations, and projecting from the extremity of the beak; inferior antennæ small as compared with size of the body.

Bosmina longirostris.

Bibliography.—Lynceus longirostris, *Muller*, Zool. Dan. Prod., No. 2394; Entomost., 76.
————*Latreille*, Hist. Nat. Crust. IV., 206.
————*Fabricius*, Ent. Syst., ii., 499.
Monoculus cornutus, *Jurine*, Hist. Nat. Monoc.
Daphnia cornuta, *Desmorest*, Cons. Gen. Crust.
————*Baird*, Ann. Mag. Nat. Hist. ii., 257.
————*M. Edward*, Hist. Nat. Crust., iii., 382.
Bosmina cornuta, *Baird*, Trans. Berw. Nat. Club.
Eunica longirostris, *Koch*, Deutsch Crust., h. XXXV. t. 23.

Description.—General form varying from nearly square to an irregular pear shape (the large portion anterior); carapace terminated on the lower posterior margin by short, curved spines. Head of moderate size, eye large, superior antennæ long, projecting from the beak, consisting of many articulations, the seventh joints furnished with setæ. Inferior antennæ small. Ova few.

The length of this animal is less than .02 in., which makes it a difficult matter to clearly discover the structure of the organs.

The superior antennæ are nearly immovable, and being closely in juxtaposition, give the appearance of a long, jointed beak or trunk. In fact, the first idea.

suggested by this bizarre creature is a peculiar burlesque on the elephant. It requires favorable light and a high power to study the nature of the antennæ. The feet are apparently wider than in Daphnia. Under a favorable light, the carapace is seen to be reticulated with hexagonal cells (at least near the edge) and is covered, in some specimens at least, by exceedingly minute tubercles. The motion is steady, progressive, and not saltatory, as in many *Daphniæ*, which is due (as in Lynceæ) to the shortness of the antennæ. The species from which this description is drawn may be distinct from the *longirostris* of Baird, but on comparing both alcoholic specimens and drawings made from living specimens, no differences of importance were detected. The reticulated and tuberculated nature of the shell may be a local variation, or may have easily escaped his notice. The form of the shell demonstrably varies, and so probably does the number of apparent joints to the superior antennæ. The species was found in only one locality, having been dipped with a bottle from the bottom through the ice. but the time of collection is lost. Later, careful search was made during autumn, but no specimens rewarded the pains. The markings, and jointing of the antennæ would make good tests for microscopes of moderate power, for such as are interested in this subject.

Habitat.—Johnson's lake, Minneapolis.

(See Plate XVII.)

TRIBE III. CYPROIDEA. Dana.

Characters.—Dana gives the following: "The Cyproidea differ from all other crustacea except the *Lernæoids* [and *Rotatoria*] in the absence of the pairs of appendages belonging to all the normal cephalothoracic segments posterior to the eighth, that is, to the six posterior of these segments. The last two of these six pairs are obsolete in all the *Lophropoda;* and i *Daphnoinea* the first four of them are n together with also another pair, next an The pairs of appendages present in the the mandibles, in number four pairs, are tween mouth and legs." This tribe embı one of which is represented in our localit general characters of the oceanic family we to the other.

FAMILY I. Cypridæ. Dana.

Characters.—Antennæ of the second pair subterete, three dibles two-branched, the main branch o the extremity, the minor branch, or palpus remote from the apex of the mandible; ey united, minute, with spherical lenses. more, slender and pediform.

SUB-FAMILY 1. CYPRINÆ. Dana.

Bibliography.—Cypris, *Muller* and others.

Cyproides (in part) *M. Edwards*, Hist. Nat. Cru

Cypridæ (in part) *Baird*, Trans. Berw. Club. ii, :

Cypridæ, *Baird*, Brit. Entomost., p. 130.

Characters.—Feet, two pairs; anterior slender and pediform, posterior weak; Abdomen elongate, bearing two clawed appendages.

The cyprinæ, in common with all the members of this tribe are enclosed in a brittle, mussel-like shell which hides from view, in general, all of body and members, except the extremities of the two pairs of antennæ and a pair of feet. They vary in size from an animal of sufficient size to be easily watched with the naked eye, and resembling a small *Unio* in shape and color, to creatures so minute that it is with the greatest difficulty that the valves of the shell are removed without destroying the parts within completely. This peculiarity of these animals renders them among the most difficult in all this order to study. The shell is usually opague, and sometime beautifully colored and fringed. When, however, the soft parts within are separated from the crustaceous envelope the beauty and peculiarity of the structure well repays the student. The shell is composed of two valves, which are only united for a short part of the dorsal margin, and which are held together by muscles which are under the control of the animal. These valves are symetrical with each other in general and are covered by a sort of varnish, which seems to repel the water so that when the creature takes air within the valves of the shell, and hence floats upon the surface it is impossible to cover it with water to prevent the glitter from the surface, while the air within prevents, by its refraction, a view of the interior in such as are transparent. On removing the shell the body is seen to consist of two parts, of which the anterior, or cephalothorax, is considerably the larger and is furnished with organs as follows: first, the eye, situated on the upper portion of the anterior aspect, which, according to Baird, has no crystallines. By Dana, however, two lenses are described; second, the superior antennæ, which are in general seven-jointed, and setigerous. These organs are always kept in vigorous motion when the animal swims. The setæ are sometimes plumose; third, the inferior antennæ. These are more like feet than antennæ and are five-jointed, and in one genus abundantly covered with (sometimes plumose) setæ. In all they are furnished with strong claws at the extremity; fourth, mandibles, which are composed of two parts, the main portion consisting of a triangular plate terminating below in a curved neck, bearing at the end a number of teeth. From the base of the neck arises a second portion, which is three or four-jointed and setigerous. From the end of the first joint of this palpus springs a small plate (branchial?) which has several fine filaments; fifth, first pair of maxillæ. These organs consist of a basal portion and the proper maxillæ which are of two rami, each ramus being furnished with setæ. There is also an attached branchial plate extending within the shell directed upwards and backwards; sixth, maxillipeds. These organs vary in Cypris. As figured by both Dana and Baird, they are of two rami, or have a "maxillary process," but in the species of *Candona* here figured they seemed to resemble the maxillipeds of the *Cyclopoidea*; seventh, first pair of feet. These are five-jointed and terminate in a strong hooked-claw which is directed forward, opposing the second pair of antennæ.

The second portion of the body or abdomen has but two sets of appendages, which are the second pair of legs and the caudal stylets. The second pair of legs are slender and four-jointed, and are directed backward along the abdomen. The caudal appendages are long and terminate in two claws. The anus opens between them. Of the other organs little or nothing is known. Baird was in doubt whether they were hermaphrodites or one copulation sufficed to render the mother and her offspring fertile for life, as in *Daphnia*. I have, however,

observed copulation in *Cypris*, and the peculiar organs represented in the p
of *Cypris* seem to be restricted to the male, so that it is certain that the s
are distinct.

These minute creatures moult frequently, casting off in the process the m
test hairs as well as the shell.

This sub-family contains two genera, both of which are represented by a
abundant species within our limits.

GENUS 1. **Cypris**, Muller.

Characters.—Antennæ of the second pair furnished at the end with a bundl
long hairs, by means of which the animal swims freely in
water. The structure is that of the sub-family.

It is very difficult to characterize the species, and it will be necessary to r
chiefly on the figures, since there is little variation in internal structure betw
the species.

Cypris vidua, Muller. (?)

Bibliography.—Cypris vidua, *Muller*, Zool. Dan. Prod. No. 2384.
————*Latreille*, Hist. Nat. Crust., IV. 245.
————*Bosc*, Man. d'Hist. Nat. Crust.
————*Desmarest*, 385, t. 55, p. 4.
————*Baird*, Trans. Berw. Club, ii. 152.
————*M. Edwards*, Hsst. Nat. Crust., iii. 399.
Monoculus viduus, *Gmelin*, Linn. Syst. Nat., 3002, No. 42.
————*Manuel*, Enc. Méth., vii., 726, No. 36.
————*Jurine*, Hist. Nat. Monoc., 175.
————*Rees*, Cyclopedia, art. Monoc.
Monoculus viduatus, *Fabricius*, Ent. Syst., ii. 496.

(I here give Dr. Baird's description verbatim for comparison with the figure

Description.—"Shell of oval form, a little sinuated on the under margin, a
beset all round with dense, fine, short hairs. The color is dull white, and t
valves are distinctly marked with three black, somewhat waved fasciæ runni
transversely across the shell at equal distances, the most anterior of the thr
being smallest. Posterior margin rather narrower than anterior."

This species, if it be the one figured beyond, is the most abundant of th
family here, inhabiting all the pools and lakes. It is quite small, appearing as
small speck, either floating on the surface or swimming rapidly about, with
sort of running motion, reminding one of the haste of an excitable man, in i
seeming uncertainty and briskness. In figure 1, the shell is represented as tran
parent, to indicate the position of the organs. The size and shape of the da
bands upon the shell vary in different individuals.

(See Plate No. XVII. fig. 1.)

Cypris neglecta, Herrick.

This species is apparently different from any other which I have seen describ
The size is very small, little exceeding .01 in. in length. The shape is a
from the side, a very perfect oval, not sinuate below, but narrower

than in front. The lower edge of the shell is rather straight, while the upper narrows behind, to form the more acute apex. The color is dull white, without markings of any kind. The shell is more gibbous than any of the other species seen, and is quite glabrous.

The antennæ and feet are not protruded as far as in vidua. This species is also abundant.

Plate No. XVII. fig. 2.

GENUS **Candona,** Baird.

Baird's Brit. Entomost., p. 151.

Characters.—Distinguished from Cypris by the absence of the tuft of long hairs on the secondary antennæ, and the consequent creeping method of locomotion, and, perhaps, by a difference in the form of the maxillipeds.

Candona ornata. Herrick.

Resembles in size C. lucens of Baird, and is of somewhat the same shape. The lower posterior margin is acute, the lower margin is sinnated and the whole margin is beset with hairs. The edge of the shell is also bordered by a series of of markings; the antennæ of the second pair are totally without setæ as far as observed; the shell is white and opaque with pearly lustre. This species is not very gibbous. (See Plate No. XX., Fig. 1.)

Candona (?) elongata. Herrick.

Shell reniform, very elongate, white, glabrous; the umbones of the valves are about two-thirds the distance from the anterior to the posterior dorsal margin; the portion of the shell anterior to the prominence thus formed is narrower than the posterior. It is questionable whether this be a member of the genus *Candona* or in reality a *Cypris*. The animal is quite large and the structure was more clearly made out than in the above. The same pair of bodies seen in the male *Cypris vidua* was found in this animal, the form of the maxillipeds, moreover, was found to differ from that given under the genus *Cypris* by Dana. It is to be hoped that some one may be able to devote a little patient study to this group and clear up the habits and structure as well as the history.

SUB-FAMILY II. CYTHERINÆ.

Cytheridæ, *Baird*, Brit. Entomostraca, 162.

Characters.—Feet six, all slender, alike and pediform.

Genus 1. Cythere, *Muller*.

Shell thin and light, tail short.

Genus 2. Cythercis, *T. R. Jones*.

Shell corrugulate or tuburculate, animal unknown.

FAMILY II. HALOCYPRIDÆ.

This family includs two sub-families and three genera of oceanic species differing in almost all the organs from the above.

SUB-ORDER **PHYLLOPODA.** (sig. Leaf-footed.)

Bibliography.—Phyllopoda, *Latreille*, Hist. Nat. Crust., IV., 130, 1802.
————*Leach*, Dict. Sc. Nat. XIV., art. Entomost.
————*M. Edwards*, Hist. Nat. Crust., iii., 351.
————*Desmarest*, Consid. Gen. Crust., 357.
————*J. E. Gray*, Synops. Brit. Mus., 1842.
————*Burmeister*, Organiz. of Trilobites, 34.
————*Lucas*, Explor. Sc. de l'Algerie, Crust., 81.
Phyllopa, *Latreille*, Cuv. Règne Anim., IV., 171.
Branchiopodes Lamellipedes and Branchiopodes, *Geans* (in part
Lamarck, Hist. An. S. Vert., V.

Characters.—Number of abnormal feet greatly multiplied.

TRIBE I. ARTEMIOIDEA.
Family 1.—Artemiodæ (Branchipodidæ.)
Family 1.– Nebaliadæ.

TRIBE II. APODOIDEA.
Family 1.—Apodidæ.

TRIBE III. LIMNADIOIDEA.
Family 1.—Limnioidæ (Estheridæ. ?)

ARTEMIOIDEA.

Bibliography.—Branchipiens, *Edwards.*
Branchiopoda, *Leuch.*
Branchipodidæ, *Baird.*

Characters.—Cephalothorax many-jointed, either covered by the carapace o
not. Appendages of the cephalothorax many, foliaceous an
branchiform. Eyes peduncled.

Artemioidea includes *Chirocephalus, (Branchipus) Eulimene, Artemia, Bran-chinecta, Eubranchipus, Streptocephalus, Nebalia, etc.* These agree in havin peduncled eyes, divided posterior thoracic legs and a straight abdomen termi-nated by spines or plates. This tribe is quite naturally divided into the tw families of which *Nebalia* constitutes the one, while the remaining genera fal quite readily into the other.

FAMILY **Artemiadæ.**

Bibliography.—Branchipoda, *Leach*
Branchipiens, *Edwards.*
Branchipidæ, *Burmeister.*
Branchipusidæ, *Baird*, 1845.
Branchipodidæ, *Baird*, later.
————Most modern authors.

Characters.—Cephalothorax many-articulate as far as the head, but nowher
covering the body. Feet foliaceous and numerous.

Dana subdivides this family, forming of the genus *Eulimene*, which has tw two branchial feet, the sub-family *Eulimeninæ*, leaving *Chirocephalus, A* etc., as the

SUB-FAMILY CHIROCEPHALINÆ.

Characters—Body slender, abdomen long and many jointed, antennæ of the second pair in the female very short and broad, while those of the male are prehensible.

GENUS **Chirocephalus.** (Sig. hand-headed.)

Bibliography.—Chirocephalus, *Prevost*, Jour. de Rhys., lvii., 37, 1803.
——— *Thompson*.
Branchipus, *M. Edwards*.
——— *Fischer*.
——— *Latreille*.
——— *Desmarest*.
——— *Guerin*.
——— *Lamarck*, etc.
Ino, *Schrank*, 1803.
——— *Oken*.
Cancer, *Shaw*.

Some member of this sub-family was found, during the autumn months, in a pool by the road-side but no accurate drawings were made and attempts to re-discover it have failed, so it remains uncertain what species it was. A figure is given of *Chirocephalus diaphanus* and the following discription, mostly from Dr. Baird's work, will serve both for a better understanding of the genus and for comparison, when other specimens are obtained.

The head consists of two segments, the posterior of which is more slender than the anterior, and is usually called the "neck."

The antennæ are very important in the whole group, as furnishing basis for classification. The superior antennæ are alike in male and female, and are filiform, straight, many-jointed, and very flexible. At the extremity are a number of small setæ. The joints of these antennæ are with difficulty seen. The length equals the head. The inferior pair of antennæ are curious organs, from which the genus derives its name, and have been mistaken for madibles and various other entirely different organs.

They are essentially prehensile organs, and consist chiefly of two large appendages, which occupy the forepart of the head, and are curved downward toward the thorax. They are articulated about the middle of their length; the first joint being large and fleshy and having a short, movable, conical appendage on its external edge; the second being curved, cylindrical, somewhat flattened at its extremity, and bearing a strongly toothed process at the base.

Arising from the base of the first joint of each of these appendages is another set of organs, called by Shaw "the trunk." These each consist of a long, flat, curved, very flexible body, composed of many short joints the edges of which are acute, giving a toothed sppearance to this organ. From the outer edges of these arise four long and flexible appendages, which are toothed near the end, and also a triangular plate which is folded like a fan when not in use. (This is removed in fiigure b of plate 1, but shown at d.) These organs are generally carried rolled under the head, somewhat in the manner of the proboscis of a butterfly, being only visible externally as a protuberance.

These prehensile organs are used in retaining the female during copulation. In the female they are much more simple, being simply two flexible, horn-like bodies, carrying none of the appendages which pertain to the male.

The eyes are large, convex and compound, and are situated on rather large peduncles, which are movable; the mouth consisting of a labrum, a pair of mandibles and two pairs of jaws.

The thorax consists of eleven segments, each bearing a pair of branchial feet, which are large and foliaceous, and consist of three joints. The first is the largest, and has on its lower edge a semicircular branchial plate, which is furnished with about forty plumose hairs; the second joint of the feet bears on its inner side three projections, each of which sends off long hairs; the third joint is long, bearing plumose setæ.

The abdomen is composed of nine segments, which are devoid of appendages, except the two terminal plates, which are beset on their edges with plumose setæ. In the female there is an external oviferous pouch.

The dorsal vessel or heart, commences near the head, and traverses the whole length of the body. When fully grown it is upwards of an inch in length, slender, of a cylindrical form, and nearly transparent. The male has a reddish tinge throughout. The tail is of a beautiful red; the basal joint of the prehensile antennæ a bluish green tipped at the end with red. The back of the female is bluish, and the ovary brown.

These are beautiful animals, and may be seen in fine weather balancing themselves, near the surface of the pools they inhabit, by means of their branchial feet; but when disturbed they strike the water from right to left, and dart away like a fish, to conceal themselves among the weeds at the bottom of the pond.

GENUS **Branchinecta.**

Characters.—Form rather slender, with the medium appendages longest, so as to somewhat resemble *Artemia* in outline, but larger; male with rather slender, rounded, two-jointed claspers. Egg-pouch much elongated.

GENUS **Eubranchipus.** (Verrill.)

Characters.—Body robust; made with large head and very stout claspers; first joint of claspers much swoolen, capable of retracting base portion of the second joint into their cavity; second joint stout at the base, in the typical species with a large tooth on the inside, the outer portion tapering, rather obtuse. Front of head between the claspers bears two thin, flat tapering appendages. Caudal appendages long. Egg-pouch short and thick.

GENUS **Streptocephalus.** (Baird.)

Characters.—Male claspers long, three-jointed, tortuous; terminal point subdivided more or less into two branches, or bearing slender appendages. Male organs long and slender. Egg-pouch elongate or conical.

GENUS **Artemia.**

Bibliography.—Artemia, *Leach*, Dist. Sc. Nat., XIV.
Artemisus, *Lamark*, Hist. An. S. Vert. (2d edit.)
Artemis, *Thompson*, Zool. Res., 104.

Characters.—Clasping organs three-jointed; egg-pouch short, broad; living in more or less saline waters.

The members of this genus, which will be often referred to, are peculiarly interesting from the way in which they show the great and sudden changes that a change in the invironment, is competent to effect in animal forms.

Three species are known in the United States, one of which is found in the eastern states, another in Utah, and still another in California, viz: *gracilis*, *monica*, and *fertilis*.

SUB-FAMILY EULEMENINÆ.

Characters.—Abdomen almost obsolete; both pairs of antennæ filiform.

GENUS **Eulimene.** *(Latreille.)*

FAMILY NEBALIDÆ.

Characters.—Antennæ large and ramiform; eyes peduncled; feet twelve pairs; carapax large, enclosing head, thorax and part of the abdomen, as in a bivalve shell.

GENUS **Nebalia.**

Bibliography.—Nebalia, *Leach*, *Thompson*, *Desmarest*, *Latreille*, *M. Edwards*, *Bosc*, *Lamarck*, etc., etc.
Cancer, *O. Fabricius*, *Herbst.*.
Monoculus, *Montagu.*
Myses, *Olivier.*

Being the only genus in the family, the above characters also characterize the genus.

TRIBE II. APHODOIDEA.

Bibliography.—Apusiens (in part), *Edwards.*
Apodidæ, *Burmeister.*
———— *Baird.*

Characters.—Body straight; cephalothorax covered by a scuteliform shell; posterior appendages of the thorax lamelliform; abdomen many-jointed; eyes sessile.

FAMILY **Apodidæ.**

Bibliography.—Apus, *M. Edwards*, Hist. Nat. Crust., iii., 356.
Phyllopoda, *Leach*, Edin. Encyclop. VII., art. Crustaceology.
Apodidæ, *Burmeister*, organization of Trilobites, 34.

Characters.—Of large size, with a rounded carapace partially covering the base of the abdomen, which is elongate and ends in two many-jointed, caudal filaments; about sixty pairs of swimming feet; antennæ rudimentary; first maxillipeds antenniform.

Characters.—Antenniform maxillipeds long; telson squarish.

GENUS Lepidurus.

Characters.—Body much shorter than in *Apus*. First maxillipeds shorter, and a long, spatulate, keeled telson projecting beyond the insertion of the caudal filaments.

Query—Should not this be reunited with *Apus?*

TRIBE III. LIMNADIOIDEA.

Bibliography.—Apusieus (in part), *Edwards*

Characters.—Body covered completely by a carapace which includes abdomen and head; eyes sessile, like *Cyproidea* in appearance.

FAMILY LIMNADÆ.

Characters.—Body compressed, with ten to twenty-seven feet, inclosed in a bivalve shell.

GENUS Limnetis.

Characters.—Shell small, round globose, without lines of growth or umbones; feet-bearing segments ten to twelve.

GENUS Limnadella.

(Uncertain. The species upon which it was founded are not now known.)

GENUS Estheria.

Shell oval, more or less globose, *Cyclas*-like with numerous lines of growth, amber-colored; animal without a "*haftorgan*"; second antennæ, with from eleven to seventeen joints to the flagella; from twenty-five to twenty-seven segments behind the head; feet twenty-four to twenty-eight; anterior feet in the males with clumsy hooks.

GENUS Limnadia.

Shell large, with four or five lines of growth, sub-triangular or broadly ovate; animal with a knob-like projection ("*haftorgan*") above the eyes; second a
with nine or ten joints to the flagella; feet eighteen to twenty-six; body

GENUS Cyzicus.

(Am not familar with any description of the generic characters.)

Remarks on the Sub-Order.—The species of this sub-order are scattered rather sparingly over the world, and many of them are dependent on peculiar circumstances for their perfect development, as in the case of *Artemia* (or Brine Shrimp) which is found in the waters of salt lakes and in the brine tubs of salt manufactories.

Of the family *Artemiadæ* several species occur throughout the United States. No *Chirocephalus* has been found west of the Rocky Mountains. *Artemia* occurs in many places, as, one in Great Salt Lake, one in Mono Lake, California, and one in the eastern U. S. The genus *Branchinectus* which has a representative in Greenland and in Labrador, has also a species in Colorado, 12,800 feet above the sea. I am not informed that any species of *Nebalia* occurs in North America.

The tribe *Limnadioidea* is without a known representative east of the Mississippi and north of San Domingo. But in Greenland and the arctic regions, *Lepidurus glacialis* is found. West of the Mississippi and east of the Rocky Mountrins are three species of *Apus*, and there has been another found on the Pacific, at Cape St. Lucas. Geologically, the genus is found in European rocks in the Triassic, and our own rocks will probably furnish species.

In the *Phyllopoda* the abdomen and thorax are merged together, and in all but the family *Artemiadæ*, there is a large carapace covering most of the body. In the *Limnadidæ* this shell is large and double, and resembles the small *Cyclas* shells of fresh water, and are often collected by Conchologists as such. The eggs are round or polygonal, and are dense and tough-shelled. The eggs are carried in an ova-sack similar to that of *Cyclops*, or in the *Limnadiadæ*. They are borne under the shell, as in *Daphnia*, etc. The young, as in other *Entomostraca*, hatch from the egg in the "Nauplius stage" described more particularly under *Cyclops*. The difference between the sexes is usually sharply defined. The process of reproduction is very interesting in many species of this sub-order. The normal method of reproduction is perhaps less common than what is known as parthenogenesis, or virgin reproduction. The eggs are produced by a simple budding process from the ovary, without fertilization by the male. The proportion of males to females is very small. In some localities the males are entirely absent. In *Artemia* the amount of saline matter in water seems to vary the comparative number of males. This affords a curious parallel with the sexual changes in the pupa of the honey bee. The saltness of the water not only affects the young, the form of the parent also varies. Schmankiewitsch found near Odessa, Russia, a species of Artemia, and by studying it discovered that it changed its form to correspond with the greater or less saltness of the water. Toward the end of the summer, when the rain and cold weather set in, the *Artemia* increases in size, and the July generation has many differences from the later ones. He then attempted to verify his observations by artificial breeding. He increased the concentration in one case and lowered it in the other, and found that after a series of generations the two sets of animals varied between themselves, and also both differed from those of the pond from which they came. He also learned that males were only produced in water of medium strength.

In the genus *Apus* similar parthenogenetic broods are produced. Siebold's experiments, which have been made with great care and minuteness, have established this fact beyond doubt.

There is great need of further investigation in this subject, and we are glad to learn that it is about to receive attention from so competent hands as Dr. Packard's.

The systematic position of the sub-order is still a matter of doubt, and it is not yet possible to make any positive classification of the divisions of the *Entomostraca*.

(See Plates XVIII. and XIX.)

ADDENDA.

Since these pages were written the Bulletins of the Illinois Museum of Nat. Hist. have come under my notice, which, aside from other interesting matter, contain descriptions of many new species of crustacea inhabiting the water of that state. Fine descriptions are given of the following species of Entomostraca, to which the student is referred, viz:

Eubranchipus serratus, Forbes.
Canthocamptus Illinoisensis, Forbes.
Diaptomus Sanguineus, Forbes.
Eubranchipus Bundyi, Forbes.
In Bulletin No. 2, Prof. Forbes describes or mentions the following:
Eurycercus lamillatus, Mull.?
Bosmina, sp.?
Ceriodaphnia angulata, Say.
Daphnia pulex, L.?
Daphnia galeata, Sars.

Later study shows that there is yet much to be done in simply verifying the species which occur here, not to mention the ever remaining opportunity for more minute study of the structure of known forms, for aside from the whole genus *Cyclops*, which has not yet been attempted, and contains numerous species, new species are constantly being met with, among which are those described beyond.

FAMILY PENILIDÆ.

Genus Daphnella. Baird.

Bibliography.—Daphnella, *Baird*, Brit. Entomost., 809.
——— *Dana*, Wilkes' Exp. Crust., page 1267.

Another member of this interesting family has been found since the text was sent to press.

The genus *Daphnella* is characterized by Dana as follows: Posterior antennæ with both rami two-jointed, the shorter ramus often imperfectly three-jointed: Head oblong, not produced beneath, bearing the anterior antennæ near the middle. *Daphnella* differs from *Sida*, which it greatly resembles, even in

minute structure, in the number of joints of the antennæ and from *Penilia*, in having the first joint of the longer ramus shorter than the second.

The branch which is three-jointed in *Sida* is not the one which has the short terminal joint.

Daphnella Winchelli. Herrick.

This species closely resembles *D. Wingii*, Baird, but I have no hesitation in pronouncing it distinct. Length .03 in. Head rather short. Carapace pear-shaped, transparent. Superior antennæ short, but appearing on either side the head when the animal is swimming, they appear to have three setæ at the extremity. Inferior antennæ very long, as long as body. The shorter ramus has four setæ on the terminal joint and one on the first, while the other ramus carries eight on the terminal joint besides. one that is much shorter than the others, and the first joint has four.

The tail has long diverging stylets, and seems not to have the minute teeth of the *D. Wingii*. The posterior portion of the front of the shell-margin is ciliated or spined. The back of the head seems to have the same appendage described in *Sida*. Ova two. This species was found in Minnetonka creek and is named in honor of Prof. Winchell.

FAMILY POLYPHEMIDÆ.

Genus Polyphemus. Muller.

Bibliography.—Polyphemus, *Muller*, *Cuvier*, *Latreille*, *Strous*, etc.
———— *Baird*, Brit, Entomost. p. 111.
———— *Dana*, Wilkes' Exp. p. 1266.

Characters—Body incurved toward the head except the posterior portion of the abdomen, which projects backward and is very slender, bearing two long spines at the extremity. Head distinct. Rami of posterior antennæ three, and four-jointed.

Polyphemus occidentalis. Herrick.

Length .25 in. Body excessively incurved, as is the head. Eye large, filling the head. Superior antennæ apparently obsolete. Inferior antennæ small. Jaws two or three-jointed, three-toothed at the apex. Feet, four pairs, first pair long, apparently four-jointed and three-clawed at the end, basal portion ciliated on the posterior margin. Fourth pair of feet nearly rudimentary. The abdomen is very long. Found in "Mud Lake," south of Minneapolis.

Eurycercus lamellatus. Muller?

Several specimens belonging to Baird's genus *Eurycercus* were found, and as far as can be determined they are not specifically distinct from *E. lamellatus*, though they are less in size and have a few minor points of difference.

I append his description, omitting the bibliography:

"Shell of an olive color; rather square-shaped, ciliated on anterior margin; ventricose in centre, and arched on posterior edge. Beak rather blunt and short superior antennæ stout, somewhat conical, slightly curved and terminating i

six spines, each of which gives out a fine seta. Inferior antennæ short compared with the size of the insect. Anterior branch has five long filaments, three from the terminal, and one from each of the other joints. The posterior branch has short spines on the two basal joints. Eye large. Abdomen very wide and densely ciliated. This is the largest member of the family, its motion is a succession of bounds. This animal is heavy and slothful compared to other species.

PLATE I.

Diaptomus longicornis, Herrick.—Back view of the female and side view of the male. *a*, basal portion of male antennæ showing geniculating joint.

a.

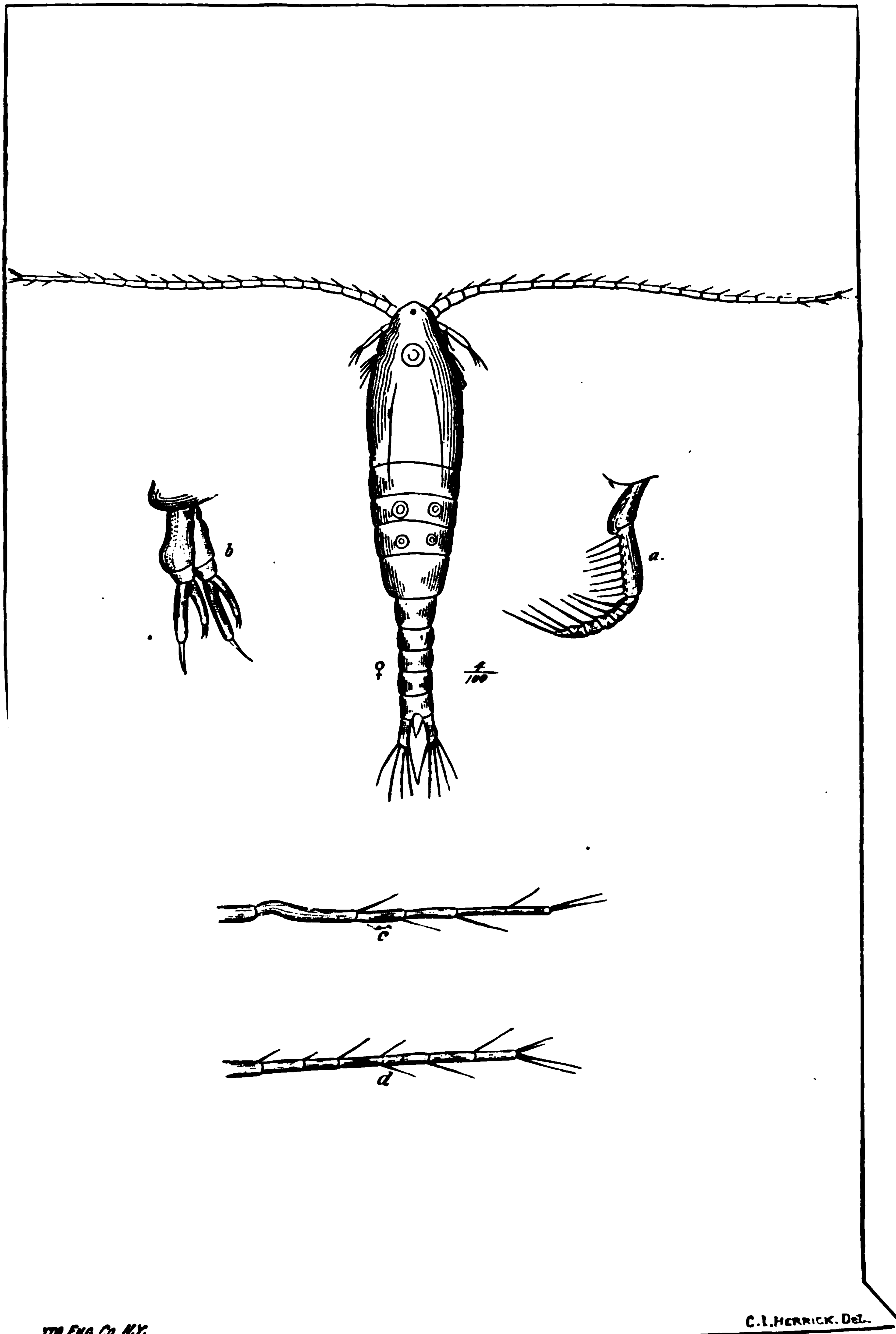
$\frac{2}{1000}$ ♀

b

Diaptomus pallidus, Herrick.—Back view of female. (In this plate the antennæ are represented far too short.) *a*, maxilliped. *b*, fifth pair of feet. *c*, extremity of male antennæ. *d*, extremity of female antennæ.

The Geological and Natural History Survey of Minnesota.

MICROSCOPIC ENTOMOSTRACA.



C. L. HERRICK. DEL.

Plate II.

PLATE III.

Cyclops quadricornis, Linn.—1, mature female with egg sacks containing ova. *a*, egg. *b*, young just born. *c*, young eight days old. *d*, young fifteen days old. *c*, young seventeen days old. *a′*, mandible. *b′*, first pair of foot jaws. 2, side view of mature cyclops.

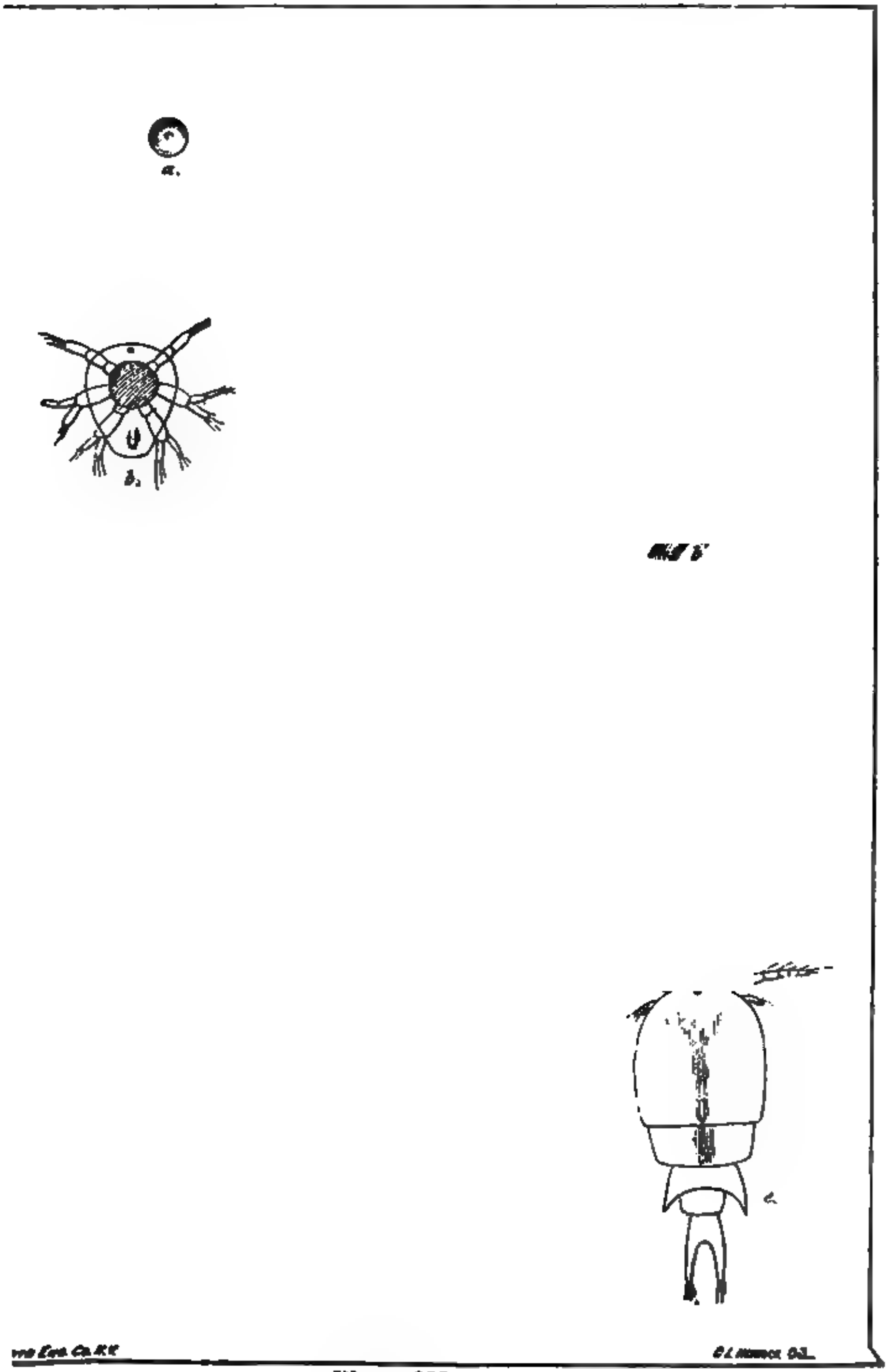
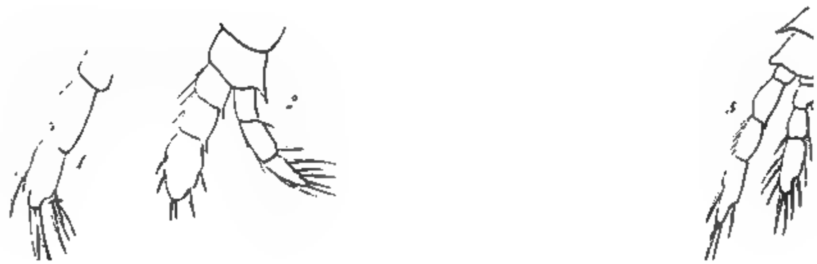


Plate III.

PLATE IV.

Cyclops quadricornis. Var?—*a*, last pair of feet **1, 2, 3, 4, 5, feet. 6, infe**

MICROSCOPIC ENTOMOSTRACA.



a.

Photo Eng Co NY C L H

PL

a, *Canthocamptus minutus*, *var. occid*

b, do., side view.

c, young, or Nauplius.

d, underview of head of male.

e. external ovary and appenda

f, antenna of male.

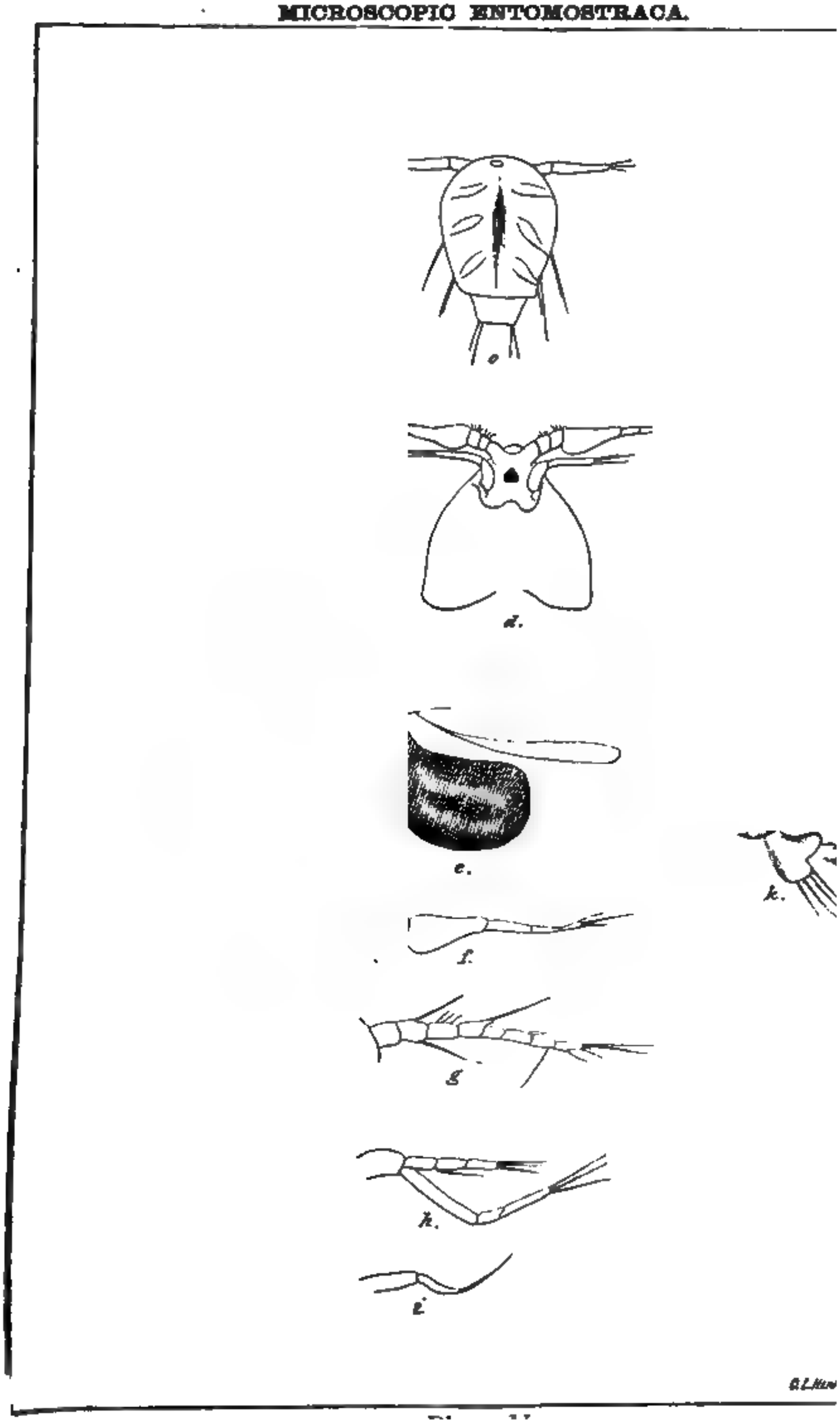
g, antennæ of female.

i, foot of first pair.

k, appendage to abdomen of fe

h, foot of second pair.

MICROSCOPIC ENTOMOSTRACA.



P

Sida crystallina, Straus. *a*, *b*, *c*,
e, extremity of abdomen. *f*

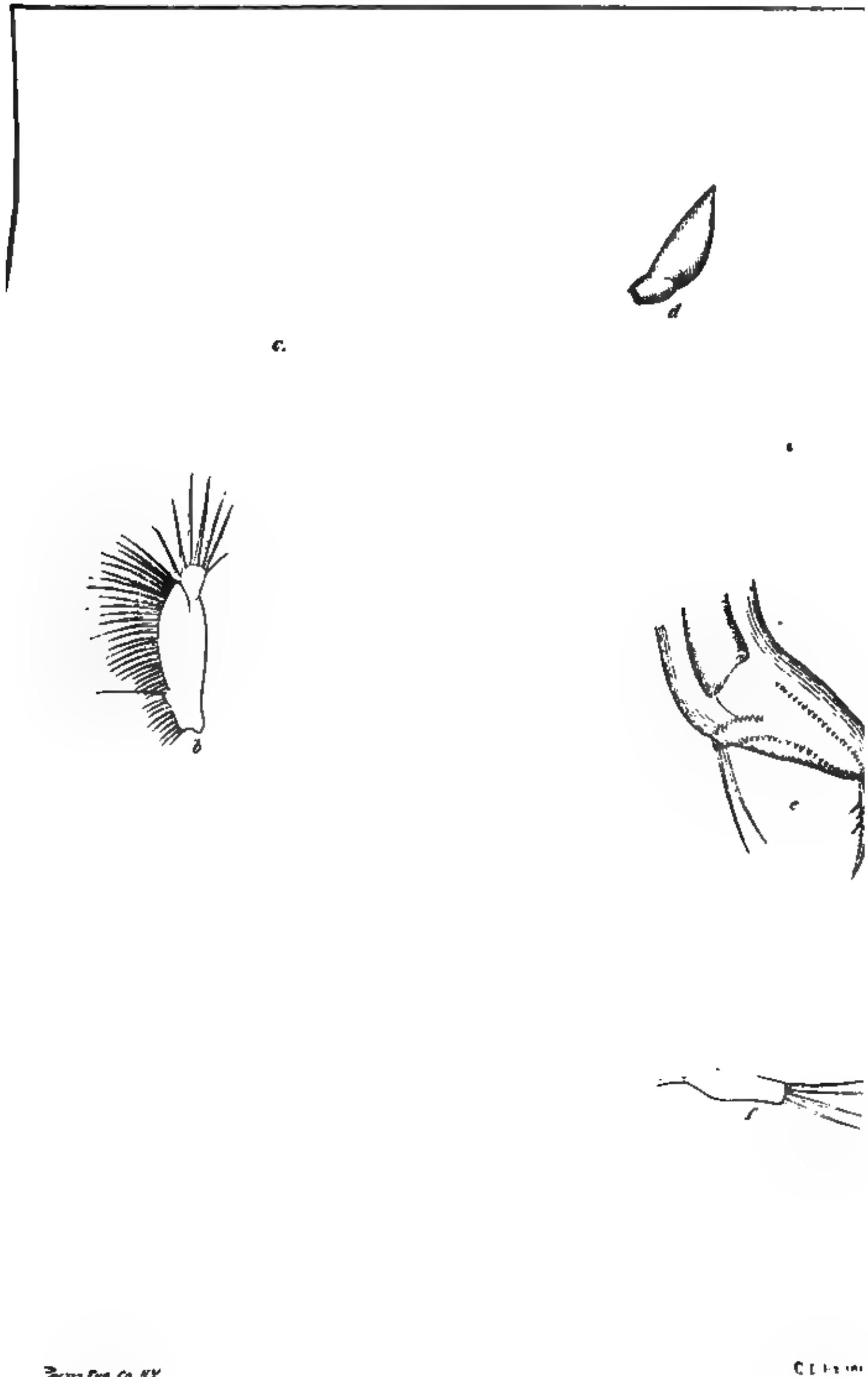


Photo Eng. Co. N.Y.

P

1. Daphnia reticulata. ***a***, superio

2. Sida crystallina. ***a***, **head.**

1. *Daphnia pulex*, var. 1.

2. ——— ——— var. 2.

3. ——— ——— var. 3.

(*a*) foot.

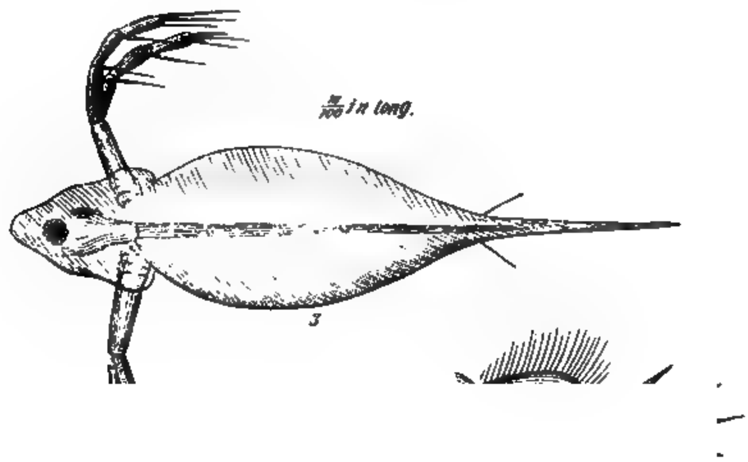


Photo Eng. Co. N.Y.

Plate VIII.

Fig. 1. Head of Daphnia Schæffe
removed. *a*, heart. *b*,
e, eye. *f*, labrum. *g*, ja

Fig. 2. Superior antennæ.

Fig. 3. Posterior portion of body.

MICROSCOPIC ENTOMOSTRACA.

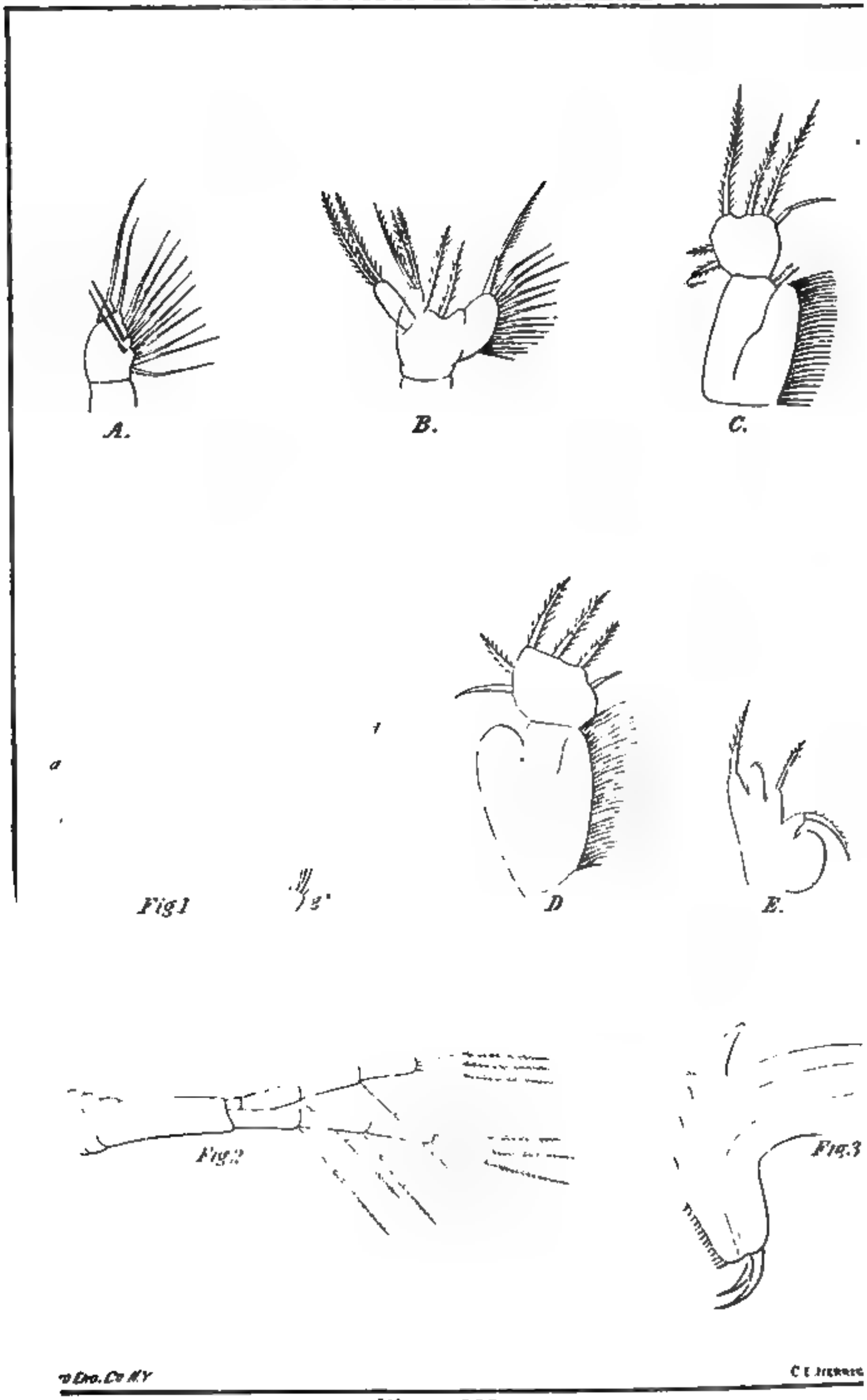


Plate IX

PLA

Daphnia vetula.—1, under view. 2, sic
a, one of the setæ from the anten
of the superior antennæ. *d*, end

MICROSCOPIC ENTOMOSTRACA.

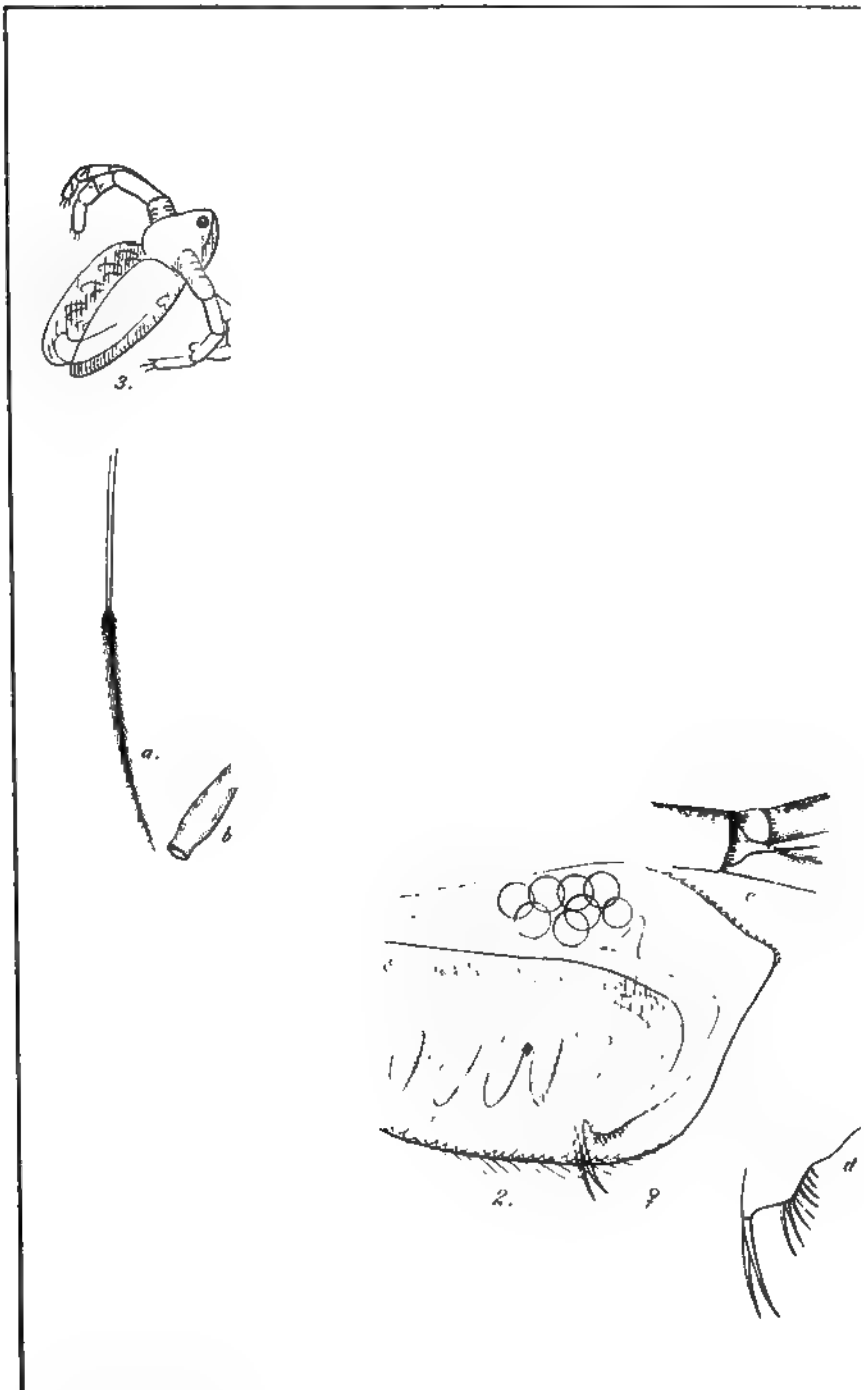


Photo Eng. Co. N.Y.

P

Daphnia vetula, male and female.

a

Photo Eng Co. N.Y.

PLATE XIII.

1, *Daphnia spinosa*, Herrick.

2, *Lynceus sp.* ?

3, *Lynceus sphæricus*.

MICROSCOPIC ENTOMOSTRACA.

3a

2a.

$\frac{3}{100}$

Cl. dV.

C.L.Herrick del.

PLA

Macrothrix agilis, Herrick. Two vie

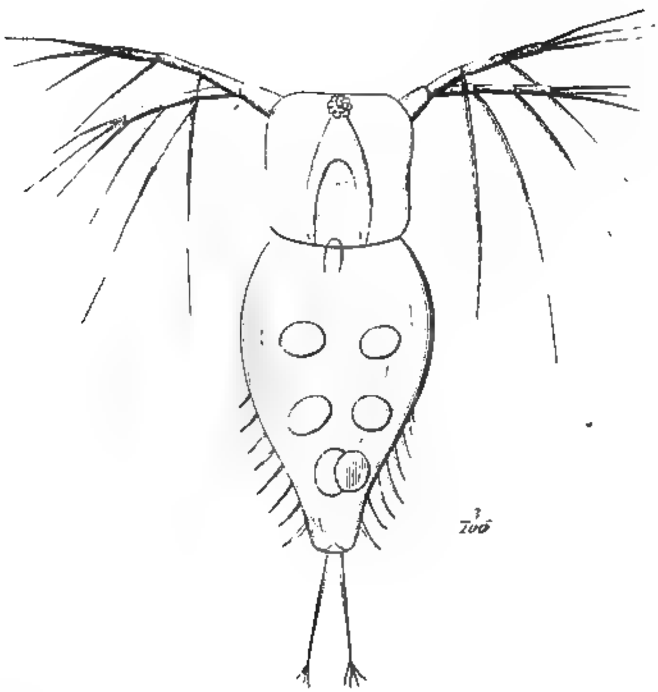


PHOTO ENG CO NY

C L HERRICK

PL

1. *Lynceus macrourus*, Muller. a.

2. *Lynceus quadrangularis*, Muller.
a, beak. b, jaws. c, end of

Eng. Co N.Y. C L Herrick Del.

Plate XV.

PLATE XVI.

1. *Bosmina longirostris.* *a*, portion of shell, superior antennæ.

2. *Lynceus sp.* ?

16 

Plate XVI.

PLAT

1. *Cypris vidua*, Muller.

1'. ——— ——— top view.

2. *Cypris neglecta*, Herrick.
a, testicle. *b*, maxilla. *c*, cau

1.

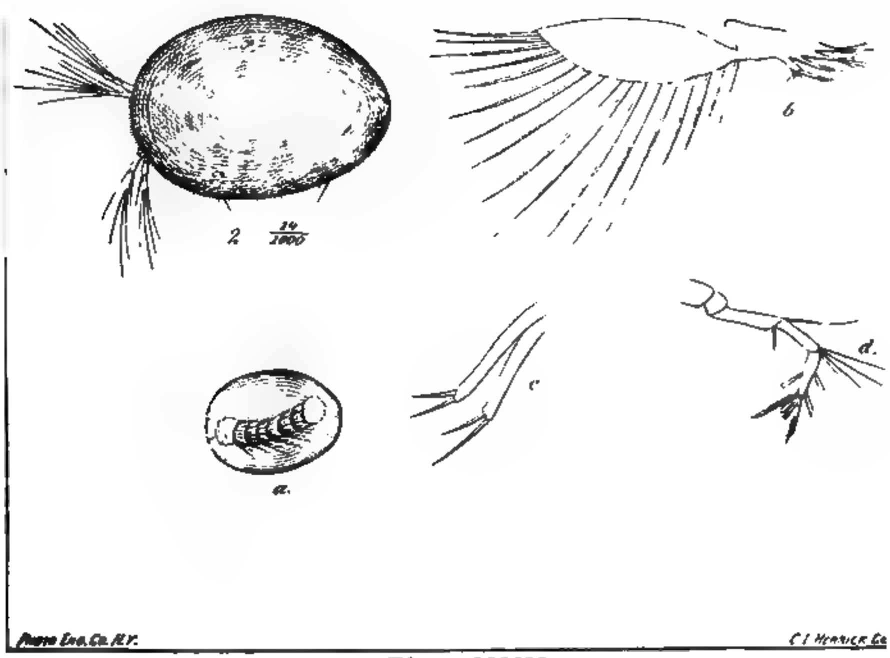


PLATE XVIII.

Chirocephalus diaphanus. ***a***, head of female. *b*, head of male with claspers removed. *c*, head of male. *d*, appendage of claspers.

Nebalia, *Streptocephalus*, ***Artemia*, *Apus*, *Estheria* and *Limnetes*.**

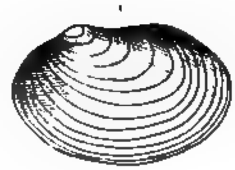


Plate XIX

PLATE XX.

1. *Candona acuata*. 2. *Candona elongata*. **2a**, testicle? **2b**,

MICROSCOPIC ENTOMOSTRACA.

2a

2b,

Photo Eng Co N.Y.

PLATE XXI.

1. Daphnella Winchelli. 1*a* Embryo. 2. Side view of same.

3. Polyphemus occidentalis. 3*a*, 1st pair of feet. 3*b*, 3d pair. *c*. jaw.

4. Eurycercus lemellatus? 4*a*. foot. 4*b*. jaw.

Plate XXI

INDEX TO THE GEOLOGICAL REPORT.

, The last line on page 13 should be transferred to be
On page 19, line 23, for *non-discovery* read *discovery*
On page 119, 7th line from the bottom, for *neared* r
On page 24, last line, insert *they*.
At variouus places in the catalogue of specimens for